The
HOW
AND
WHY
Wonder Book of

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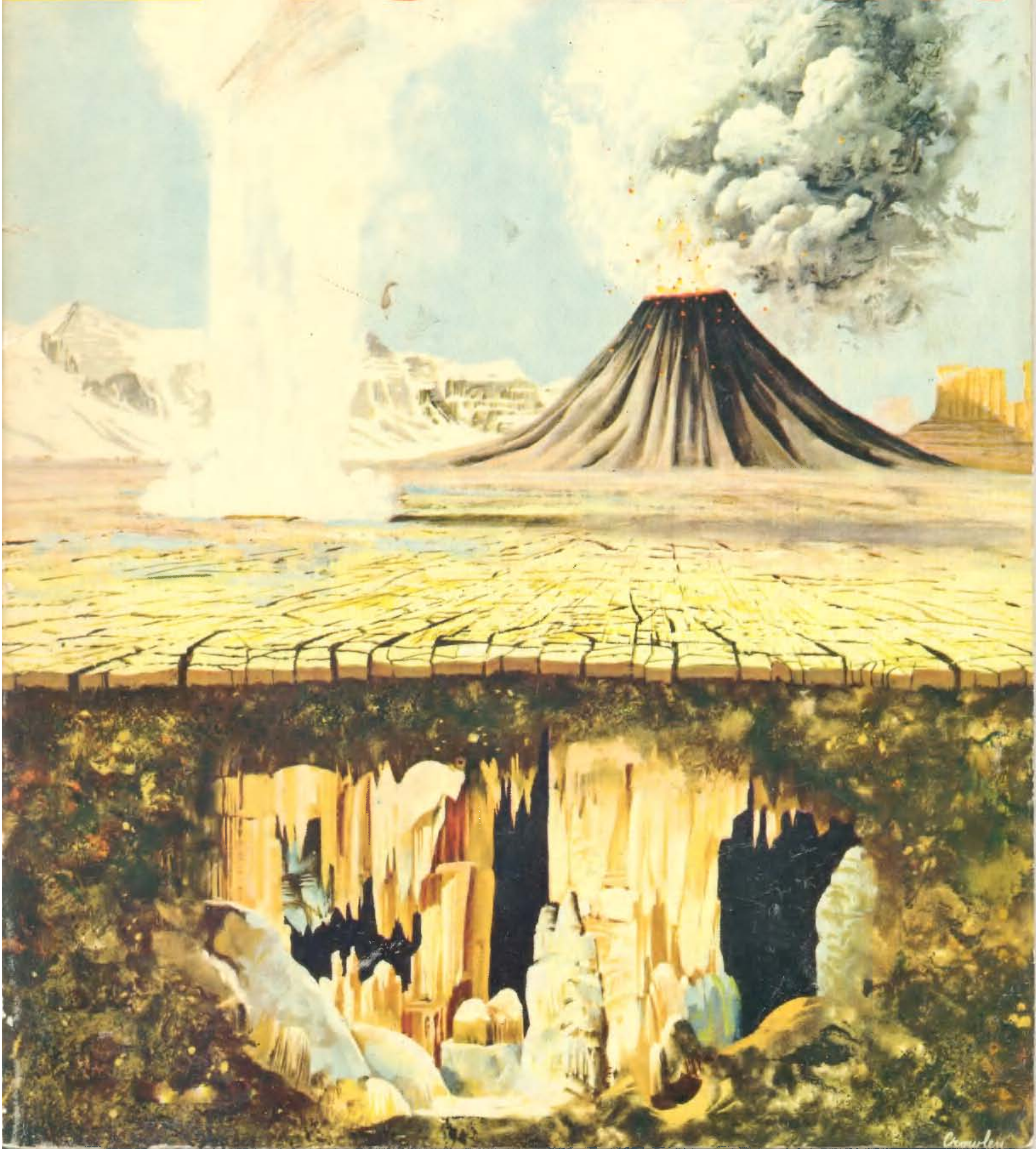
OUR EARTH



THE HOW AND WHY WONDER BOOK OF
OUR EARTH

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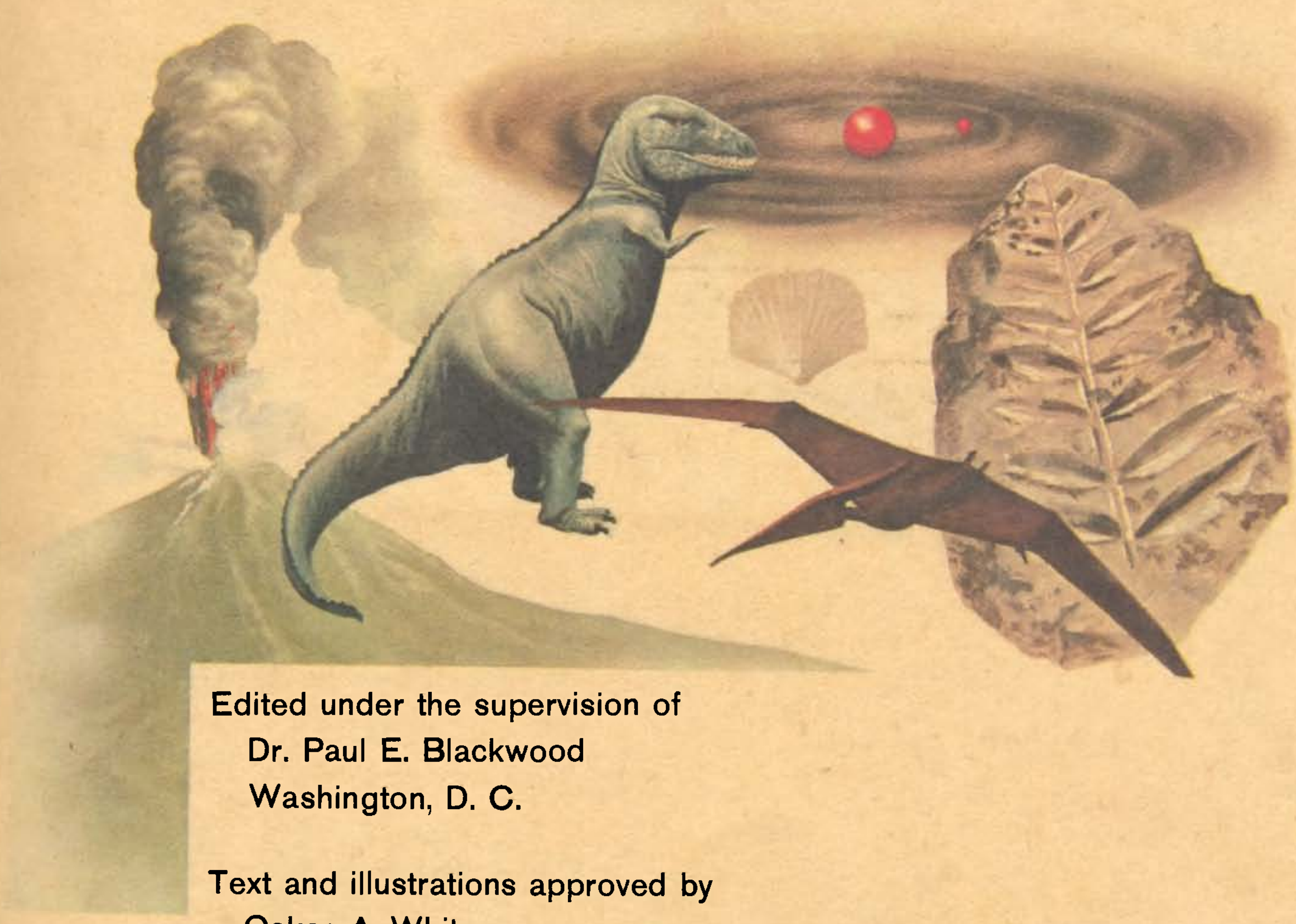

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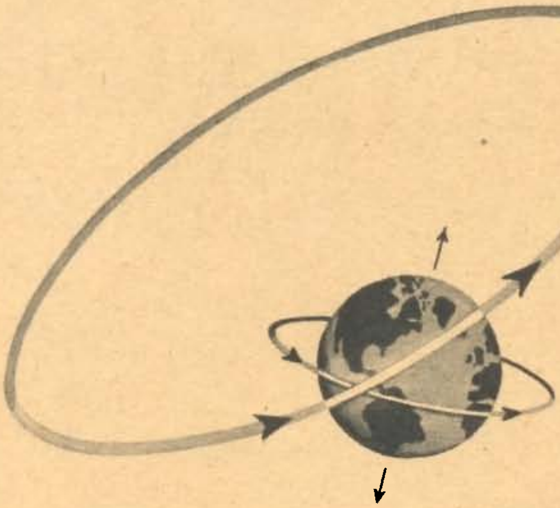

Introduction

Earth, at this writing, is still the home of all known people. And though it is fun to speculate about life on other planets in our solar system and in other star systems, most of us will continue to live on earth. So it makes good sense to learn as much about our home planet as we can.

This *How and Why Wonder Book* is a good guide to learning more about the earth. It deals with a variety of topics and answers many questions. How was the earth formed? What is inside the earth? What causes volcanoes? What do fossils tell us? How are mountains and seas formed? Indeed, the book is really *geology,* the study of the earth, made easy.

A fascinating aspect about the study of the earth is that we can see today the same processes that have been going on for millions and millions of years in the past. Reading the book gives one a feeling of living with the history of the earth and learning about it at the same time.

Parents, teachers and children alike will profit from reading the book. It is surely an essential addition to the growing *How and Why Wonder Book* library of every young scientist.

Paul E. Blackwood

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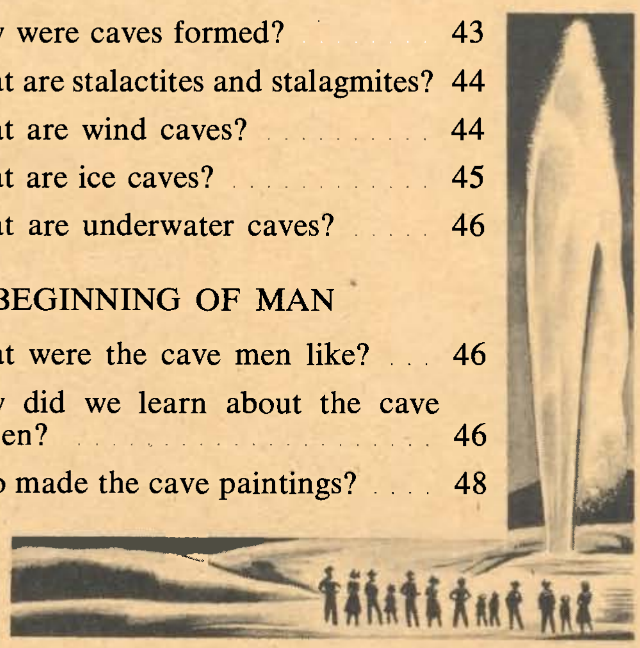
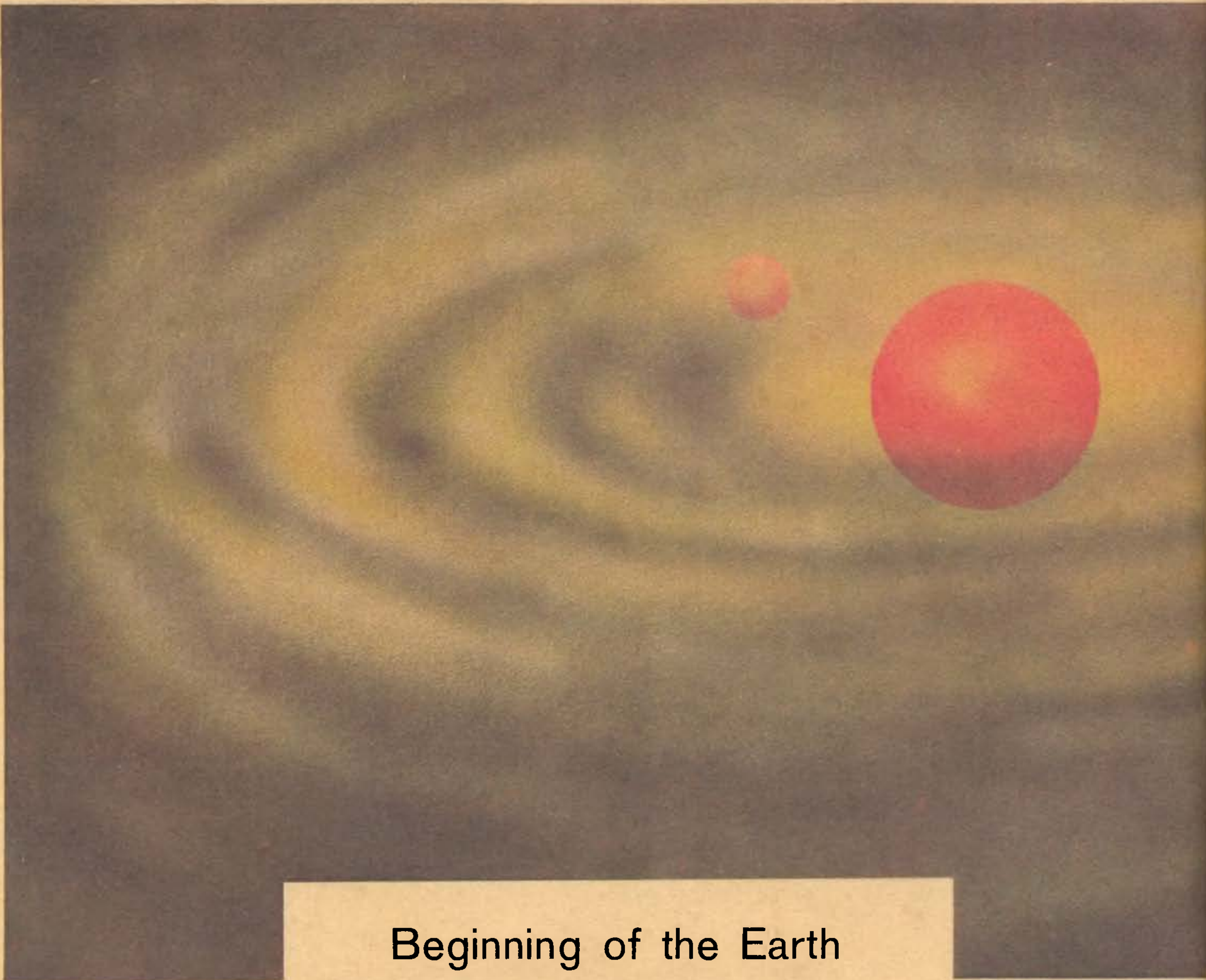
Contents





Beginning of the Earth

How was the earth formed?

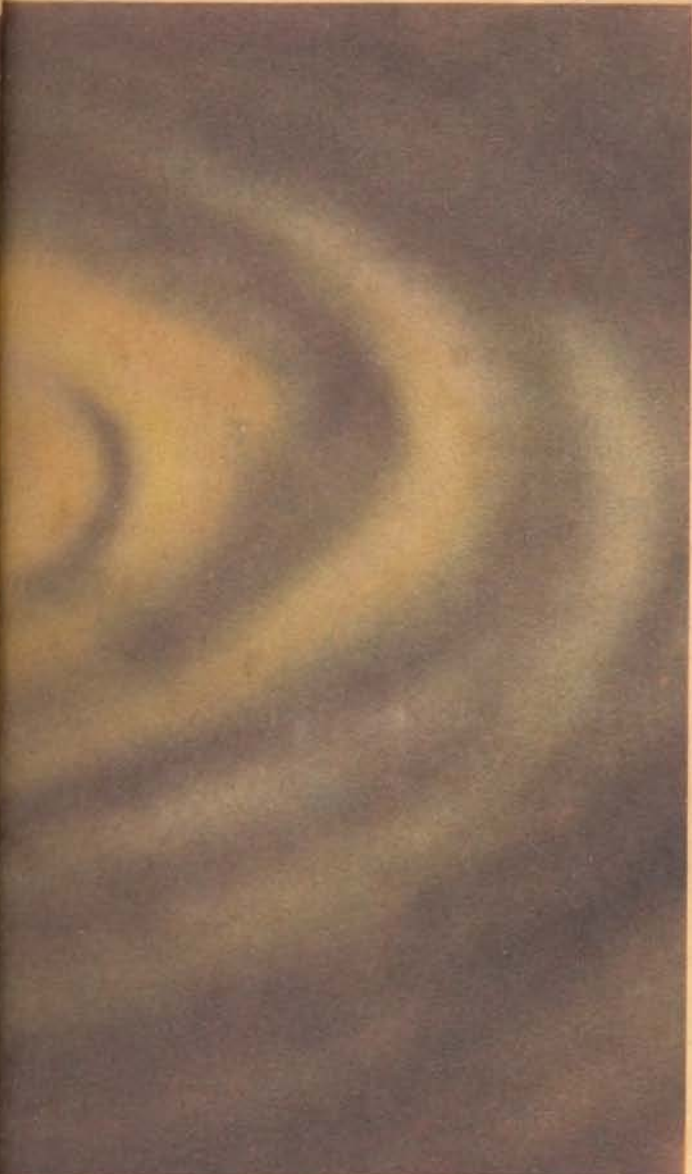
Scientists believe that about a hundred thousand million years ago the earth, sun, and all the planets of the solar system were nothing but a cloud of cold dust particles swirling through empty space.

Gradually, these particles were attracted to each other and came together to form a huge, spinning disc. As it spun, the disc separated into rings, and the furious motion made the particles white-hot.

The centre of the disc became the sun, and the particles in the outer rings turned into large fiery balls of gas and molten liquid. Then they began to cool and condense and take on solid form. And at last, some four or five thousand million years ago, they became Earth, Mars, Venus and the other planets.

What is the earth like inside?

Essentially, the earth is constructed something like a baseball. If you were to cut a baseball in two, you would see that it has a core of solid rubber. Wrapped around this inner core are a great many layers of heavy string. This

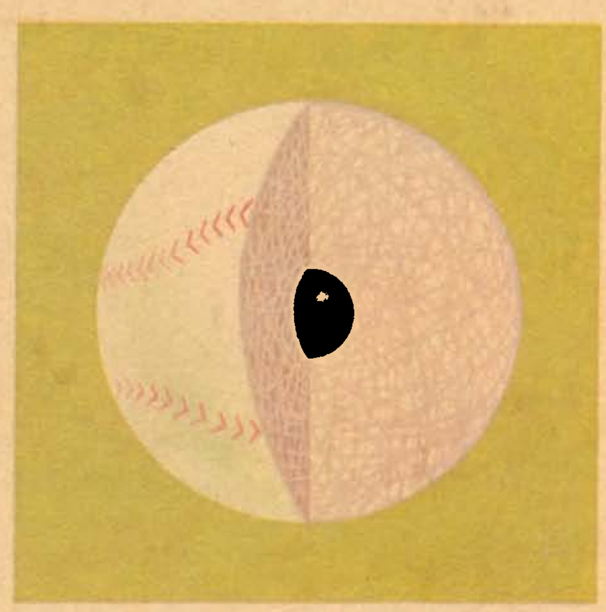


string binding is solid, yet it is not as solid as the rubber core, for it will give and sometimes alter its shape under pressure. The outer covering is a thin layer of horsehide which holds in all the rest of the ball.

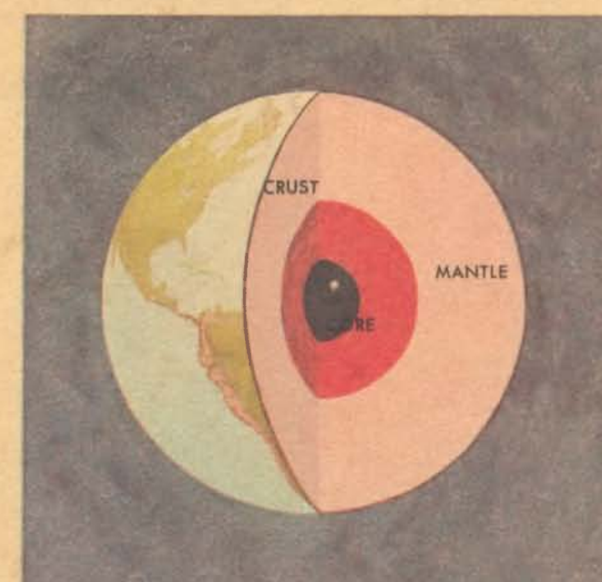
The solid-rock covering of the earth, called the *crust,* is between ten and thirty miles thick — much thinner in proportion than the horsehide covering of the baseball.

Under this crust is a thick layer of a different kind of rock, which is known as the earth's *mantle*. The rock of the mantle is solid, but it is solid in the same way that the string wrapping of the ball is solid. Under pressure it will move slightly and change its shape. The mantle extends to a depth of 1,800 miles.

Enclosed by the mantle is the earth's *core.* Unlike the centre of a baseball, the centre of the earth is made up of two parts: an *outer* core and an *inner*



As the illustrations indicate, the construction of the earth may be compared to that of a baseball. The earth's covering is called the *crust.* Under it is the *mantle.* Within that is the core (centre of the earth).



core. Both are composed of metal — mostly iron, with some nickel — but the outer core is liquid and the inner core is solid. At the very centre of the core, the temperature is about 8,000 degrees — not much less than the temperature on the surface of the sun.

The total distance from the earth's surface to its centre averages approximately 3,960 miles.

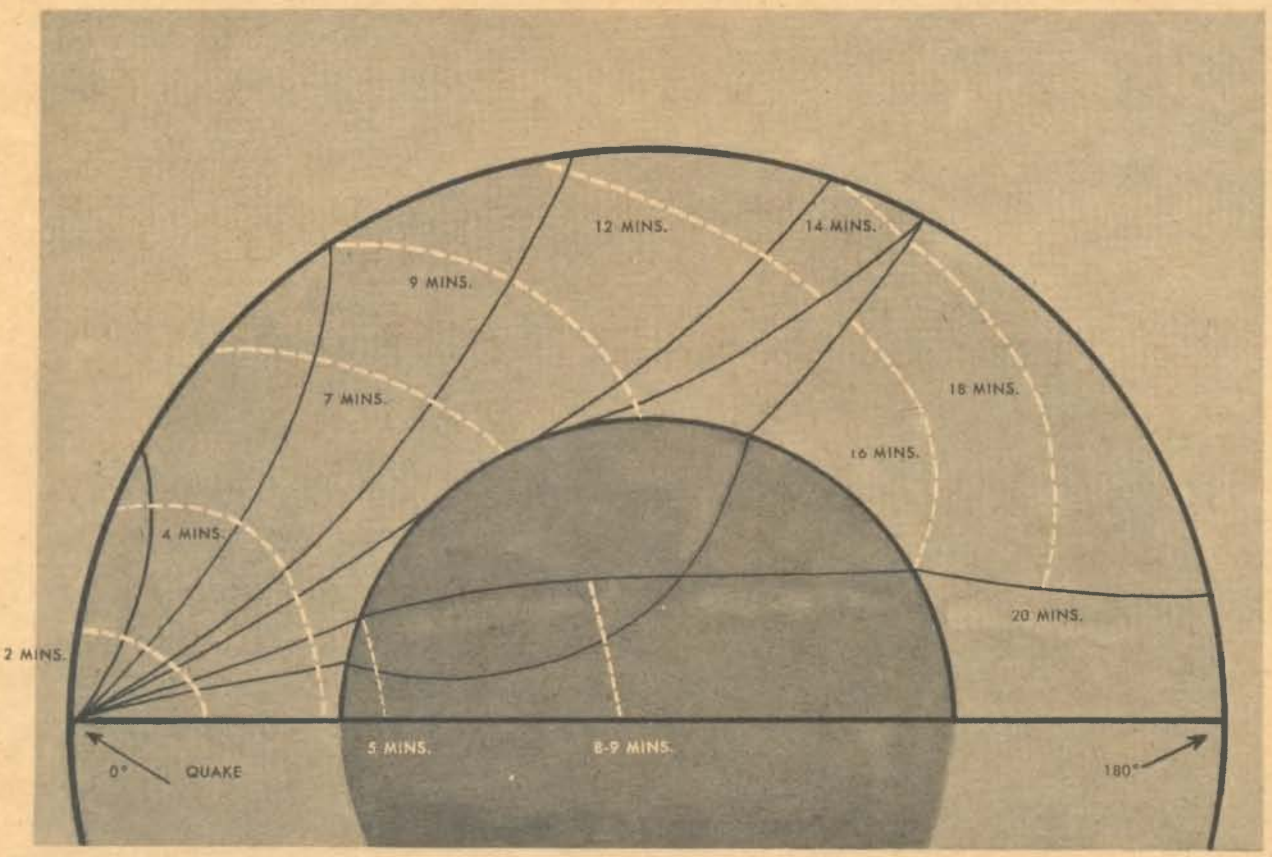
How can we tell what the inside of the earth is like?

No scientific instrument has ever penetrated more than two or three miles into the earth, How, then, are we able to tell what the inside of the earth is like? The answer is: by the action of *earthquakes.*

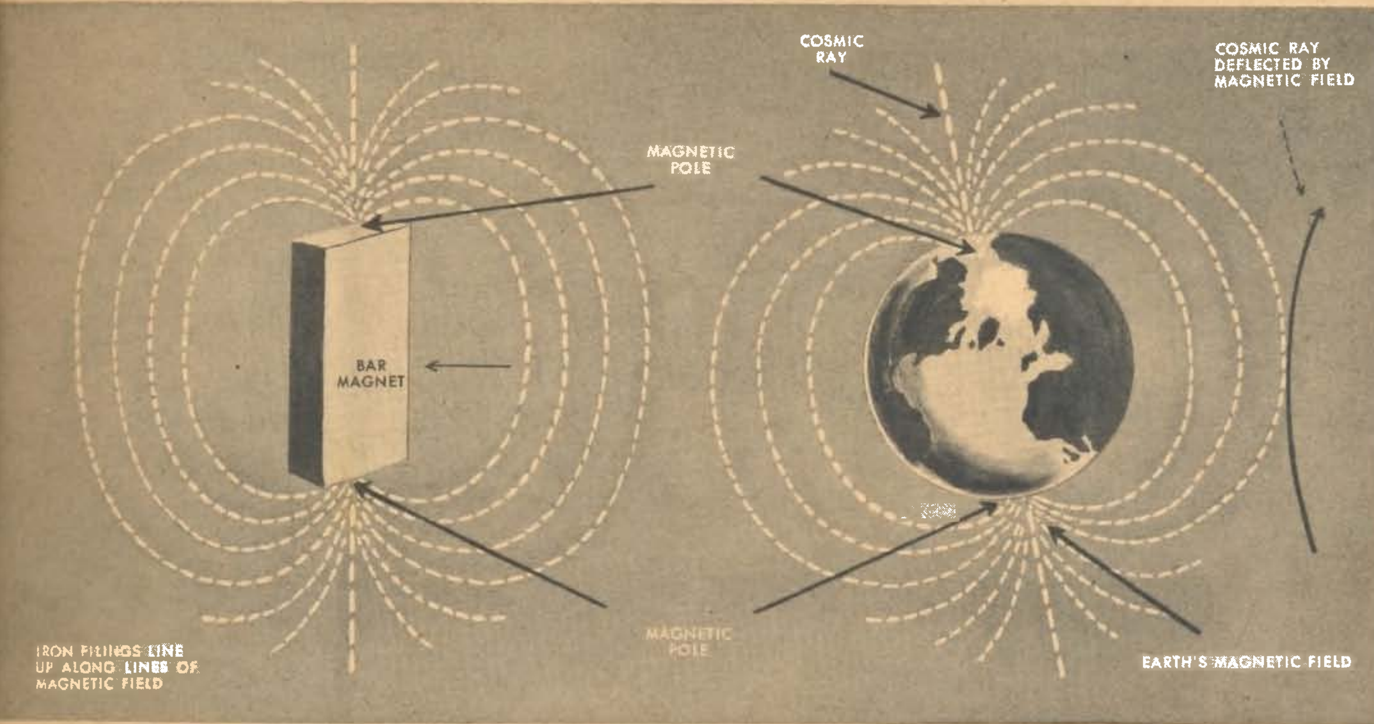
Thousands of earthquakes occur every year in many parts of the world. Most of them are too slight to cause damage, but all of them send out shock waves that penetrate all through the earth, even the deepest parts.

These earthquake waves are of two basic kinds: P (primary) waves, and S (secondary) waves. P waves travel faster than S waves. P waves go through liquids, but S waves can't. The speed of both P and S waves vary according to the depth of the earth they have penetrated. Both behave differently when passing through different kinds of rocks.

When these waves come back to the surface, they are recorded on a delicate instrument called a *seismograph*



By studying the speed and behaviour of earthquake waves, scientists can tell what the inside of the earth is like.



These diagrams show the magnetic field of a bar magnet (left) and the magnetic field of the earth (right). Note that the North and South Magnetic Poles are not in the same positions as the geographic North and South Poles.

(SIZE-mo-graf). And it is by studying the speed and behaviour of the P and S waves — the distance they have travelled from their point of origin, the depths at which they have been reflected and bent, and the time it has taken for them to make their journey — that scientists are able to determine what the inside of the earth is like.

Why does a compass point north?

The fact that the earth is a gigantic magnet was discovered more than a thousand years ago. But people did not know what they had discovered. They knew that if a needle was stroked by a *loadstone* (a mineral, which is a natural magnet), the needle would always point north. But they supposed that the needle was attracted by the North Star. We know now that the needle is attracted by the North Magnetic Pole.

We know today that the magnetic pole is as much as a thousand miles from the true, or geographic, pole. But the two poles are always just about the same distance apart.

What causes the magnetic field?

There are a great many things about the earth's magnetism that scientists still do not know. But the most widely accepted theory is that the magnetic field is set up by electric currents deep within the earth's liquid core. These currents are created when minerals of different temperatures and different electrical properties come together. This means that the inside of the earth is a huge, natural generator, which is constantly turning mechanical energy (the earth's rotation and the movement of the liquid core) into electrical energy. And, of course, we know that all magnetic fields are the

result of electric currents, and all electric currents are surrounded by magnetic fields.

How can you make your own compass?

Take an ordinary needle from your mother's sewing basket and stroke it a few times — always in the same direction — with a toy magnet which you can buy for a few pence in any toy store. Now cut a very thin slice from an ordinary bottle cork, and float it on top of a glass dish full of water. Place the needle on the cork, and it will make the cork swing around until the needle is pointing north and south.

Have the North and South poles ever changed their positions?

From their studies of ancient rocks and fossil animals and plants in many parts of the world, geologists know that some lands which now have a tropical climate once lay buried beneath sheets of glacier ice. They also know that what are now the Arctic and Antarctic regions at one time enjoyed a much warmer climate. These studies suggested that the North and South poles had shifted their positions throughout earth time, and, of course, the Arctic and Antarctic icecaps had moved with them.

Scientists can now measure the very weak magnetism of many different

From measurements of the magnetism of ancient rocks, as well as from studies of fossil animals and plants, scientists know that the geographic North and South Poles of the earth have changed positions.

kinds of rocks. Some of this weak magnetism is left over from the original magnetism given to the rocks when they were first formed many millions of years ago. Since this original magnetism does not point to the poles as they lie today, we must assume that their locations have shifted since the rocks were formed.

Five hundred million years ago, the North Pole was near the equator in the eastern Pacific. One hundred and seventy million years ago, early in the Age of Dinosaurs, it lay in Siberia.

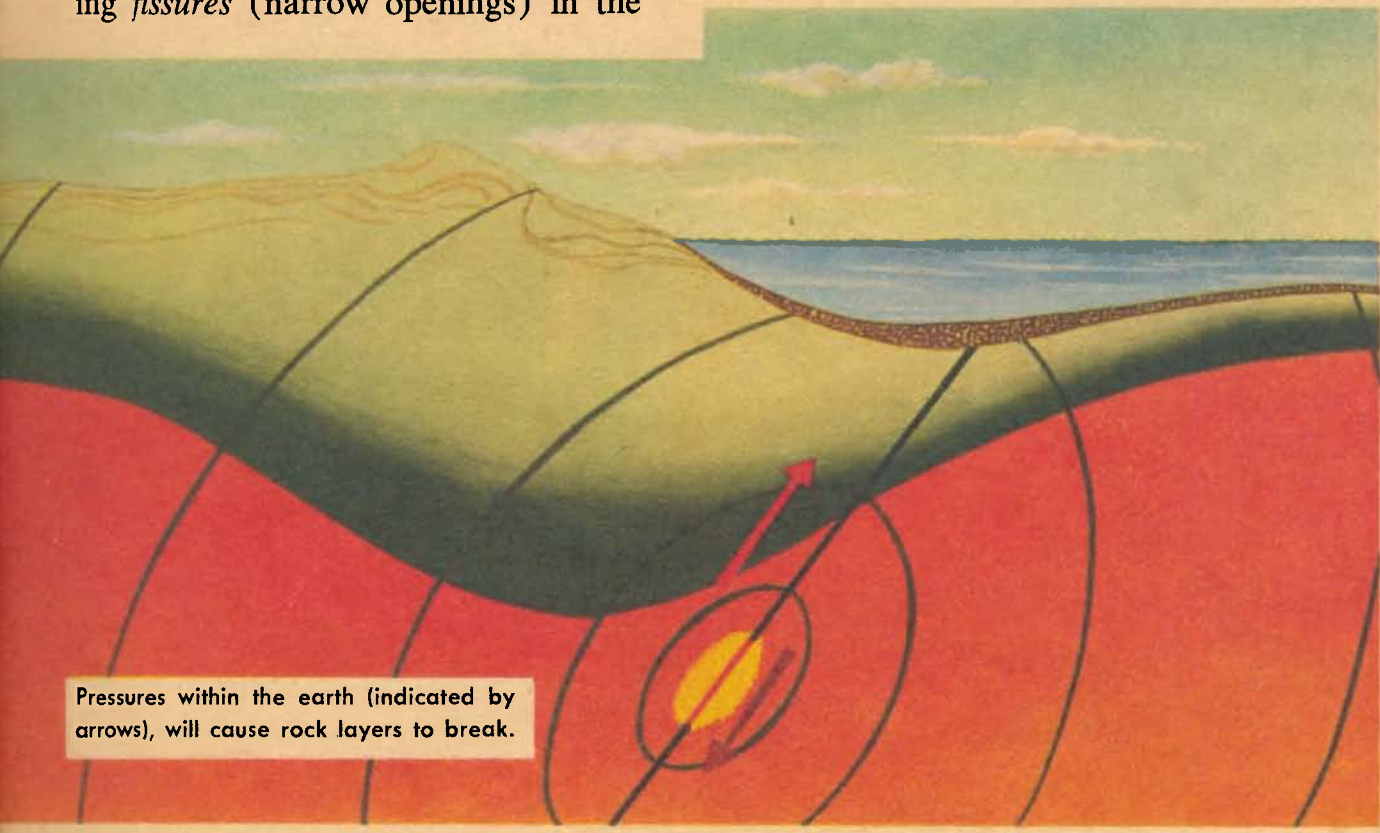
So, since the poles have shifted in the past, there is no reason to believe that they will not continue to do so in the future. Hundreds of millions of years from now, the polar icecap might very well be somewhere in Connecticut or California or Kansas, while Alaska has a tropical climate.

Upheavals in the Earth

What causes earthquakes?

Most of the time, the surface of the earth is firm and steady. But sometimes the ground shakes and trembles, jarring masses of rocks loose from mountainsides, causing *fissures* (narrow openings) in the surface, and knocking down buildings in cities and towns.

We know that the thin outer crust of the earth is formed of uneven layers of different kinds of rocks. These rocks are subject to constant pressures, not



Pressures within the earth (indicated by arrows), will cause rock layers to break.

only from the rock layers that lie above them, but also from forces within the earth itself. These pressures bend the rocks and cause them to change shape.

If these pressures are great enough, the rock layers may suddenly break — in the same way that a stick will give just so far when you bend it in your hands, and then suddenly snap in two.

When this happens, the rocks break apart and snap back just as the two broken ends of the stick do. This sudden snap jars the earth's crust and causes it to shake. And this movement is called an earthquake.

How were the mountains formed?

If we were able to slice open a mountain range such as the Rockies, the Andes or the Alps, we would see that the layers of rocks had been broken, bent and crumpled. We would also find that many of the rock layers that now tower thousands of feet above sea level were once formed at the bottom

of the ocean. We know that this happened because the fossil remains of sea animals have been found in rocks on the topmost peaks.

From these facts, we conclude that the mountains were formed from the rocks of ancient sea floors — and that powerful forces from within the earth broke and folded and raised these rocks into their present positions.

When the mountain ranges rose slowly out of the sea in this way, other forces began at once to go to work. Swift-flowing streams and slow-moving glaciers began tearing the mountains away. (This process of wearing away — usually, wearing away land by the action of moving water — is called *erosion.*) Landslides moved material from higher places to lower ones. As soon as the mountains rose above the sea, erosion began to destroy them.

Geologists believe that the surface of the earth is constantly changing in this way — that the earth's crust is in constant motion, like the waves on the

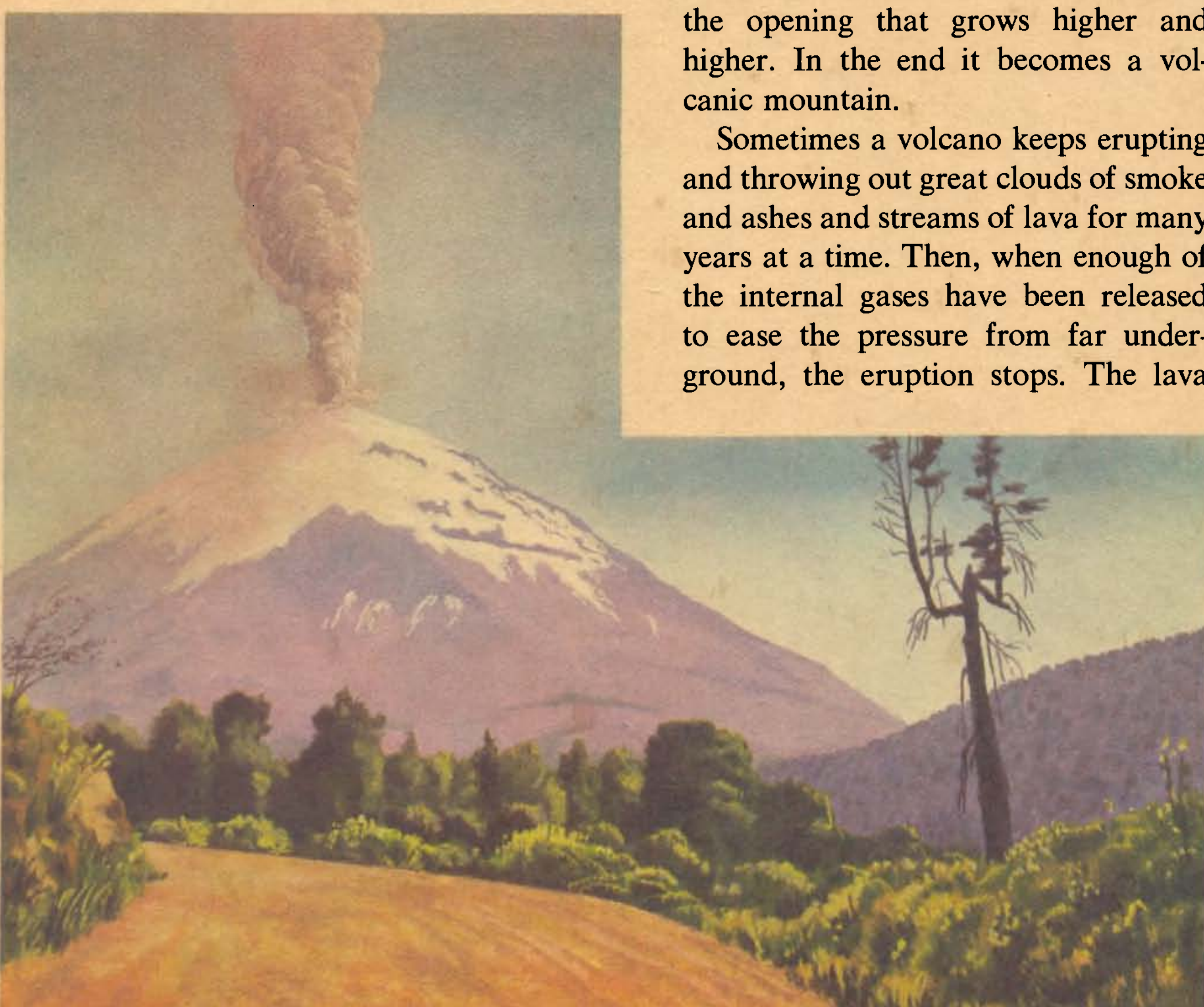
Aerial view of volcanic ridges and mountains

surface of a sea. But instead of rising up and levelling off again in a split-second, as sea waves do, the movement of the "waves" of the earth's surface is measured in terms of hundreds of millions of years.

What causes volcanoes?

The solid rock layers which form the earth's crust are thicker in some places than in others, and directly underneath them, the earth's internal temperature is hot enough to melt rock. This molten rock is known as *magma* (MAG-ma).

Eruption of a volcano: Mount Popocatepetl in Mexico.



At certain places under the crust, magma collects in reservoirs or pools. As this magma wells up out of the insides of the earth, it pushes gases ahead of it. As the gases become more and more tightly compressed, they exert a tremendous pressure against the underside of the crust. If this occurs at a place where the crust is weak, or where an ancient earthquake has created a break in the rock, the mixture of gas and magma breaks through the crack and erupts on the surface in the form of lava.

As the lava gushes out through the crack in the earth, it cools and solidifies and, in time, forms a cone around the opening that grows higher and higher. In the end it becomes a volcanic mountain.

Sometimes a volcano keeps erupting and throwing out great clouds of smoke and ashes and streams of lava for many years at a time. Then, when enough of the internal gases have been released to ease the pressure from far underground, the eruption stops. The lava

inside the cone then cools and plugs up the crack in the crust. Often, many years later, the pressure builds up again, blows out the plug of solid lava, and the volcano erupts once more.

Why does a geyser throw out steam?

Geysers might be described as small distant cousins of volcanoes, for they too are created by the earth's internal heat.

Water from the surface penetrates deep down into long vertical cracks in the underlying rock which act as natural "water pipes." When this water sinks deep enough, the heat of the earth causes it to boil. Then the whole column of water and steam shoots up out of the top of the "pipe" to produce the beautiful fountain display for which geysers are famous. After the geyser has erupted, the whole process begins all over again.

Geysers exist in only three places in the world: Iceland, New Zealand and Yellowstone National Park in the western United States. Of these, the Yellowstone geysers are the most numerous and most spectacular. Yellowstone's most famous geyser, "Old Faithful," erupts at fairly regular intervals of about an hour.

How can you make your own geyser?

You can make your own geyser by putting a funnel mouth-down in a saucepan. Fill the pan with water until only the neck sticks out. Place a spoon or some other small object under one lip of the funnel so that the water can get under it. Now put the pan on a fire. As the

Eruption of a geyser: "Old Faithful" in Yellowstone.

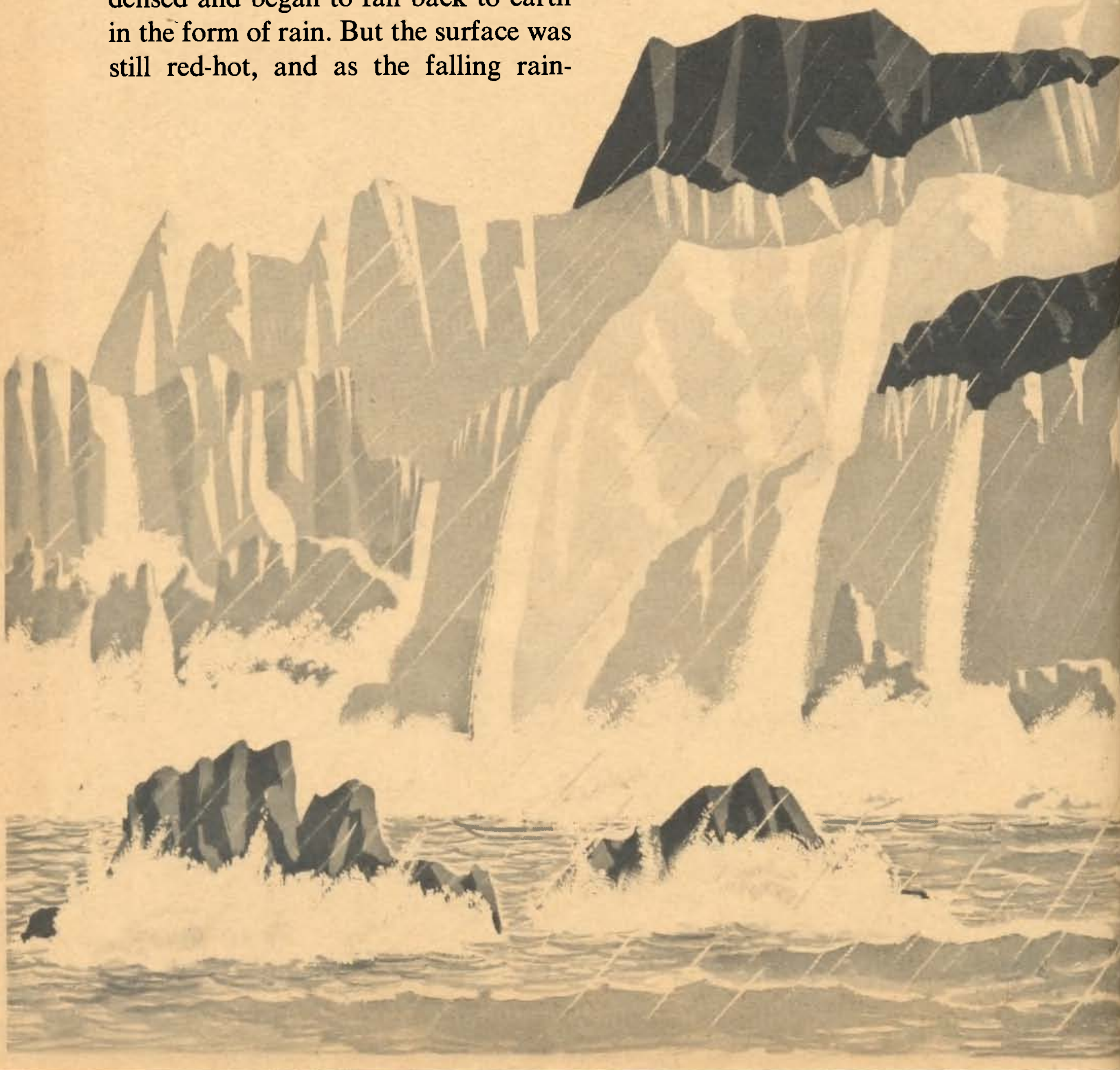
water at the bottom of the pan boils, it is forced out of the top of the tube, in the same way that a geyser erupts.

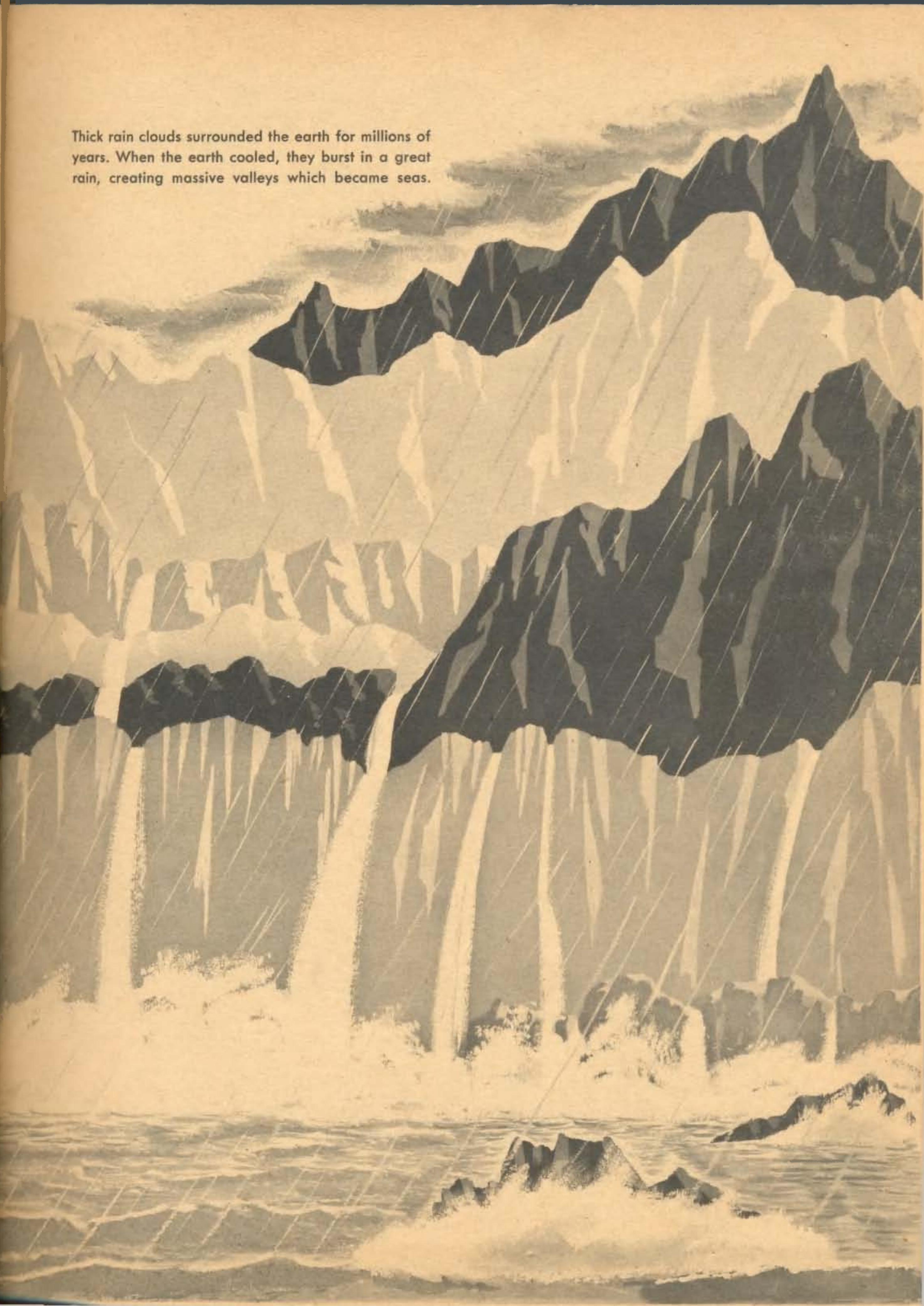
How were the seas formed?

As the molten rock that formed the surface of the young earth began to cool and solidify, gases bubbled up out of the seething interior of the globe and escaped into the atmosphere that surrounded it. Here they collected together into great clouds of water vapour. When these clouds became heavy enough, the moisture condensed and began to fall back to earth in the form of rain. But the surface was still red-hot, and as the falling raindrops approached it, they boiled away and returned into the upper atmosphere as vapour.

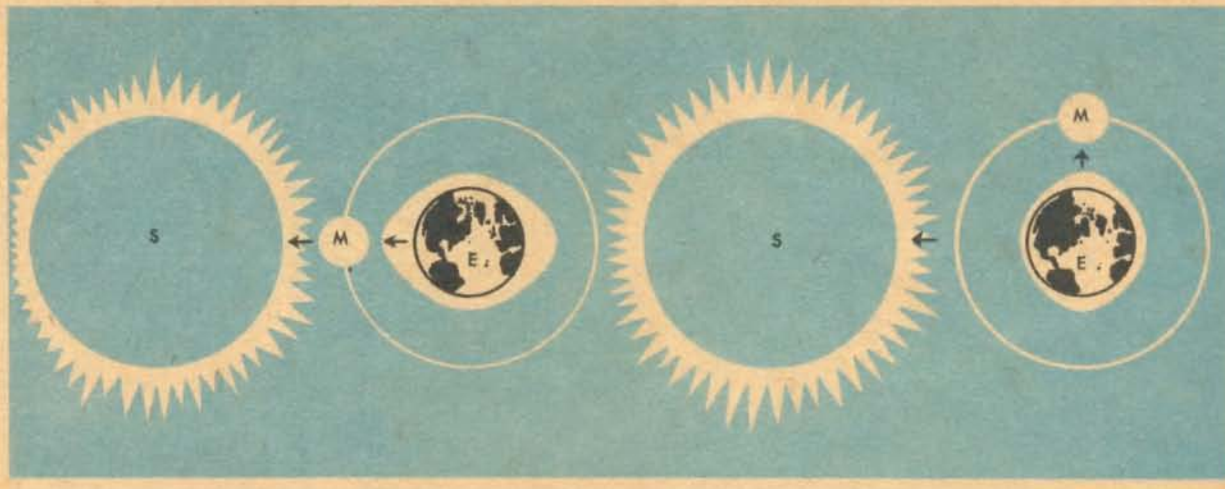
You can see how this happened by heating a griddle on a stove. When the griddle is hot, slowly drop water on it from an eye-dropper. You will see that as the drops of water touch the hot surface of the griddle, they immediately boil away as steam vapour.

So, for probably millions of years,





Thick rain clouds surrounded the earth for millions of years. When the earth cooled, they burst in a great rain, creating massive valleys which became seas.



Spring tides: Sun, earth and moon are in a straight line. Neap tides: The moon is at right angles to the sun.

the earth was surrounded by a heavy blanket of rain clouds that was many miles in thickness — endlessly condensing, falling as rain, and then being boiled back up into the sky again.

Then, slowly, the earth's crust hardened and cooled. And at last the surface rocks became so cool that their heat would no longer boil water. And the rain that had been collecting for all these millions of years up in the thick blanket of clouds began to fall in a never-ending torrent.

For hundreds, perhaps thousands of years, the rains came pouring down in a solid cloudburst. They levelled off mountain ranges and cut great valleys in the earth. And when at last the deluge had slowed and stopped, the lowest levels of the earth's wrinkled and folded crust had been filled up with water. These were the first oceans.

Why is sea water salty?

The rivers that flow across the face of the land carry millions of tons of silt and sediment down to the oceans each year. These dissolved materials contain nearly all the minerals that are found in the earth, including vast quantities of salt.

The heat of the sun evaporates, or dries up, some of the water on the sea's surface and sends it back into the air as water vapour. There it condenses into clouds and falls back to earth as rain or snow.

But in this process of evaporation, the minerals are left behind in the oceans. Some of them, like iron and calcium, are absorbed by the sea's animals and plants. But the salt is not used by either the animals or plants and so it continues to collect in the sea in ever-increasing quantities.

What causes the tides?

Anyone who has been to the seashore has seen the daily ebb and flow of the tides. At certain times of day the level of the water rises, usually ten or twenty feet. Then it recedes and leaves a long, empty stretch of beach behind it. This is caused by the gravitational pull of the sun and the moon.

During the periods of new moon and

full moon, the sun, the earth and the moon are all in a straight line. And so both moon and sun work together to cause extremely high tides, known as "spring tides."

On the other hand, when the moon is in the first and third quarter, it is at right angles to the sun. Under these conditions, the pull of the sun and moon tend to offset each other, and thus the tides are lower. These are called "neap tides."

But there are other puzzling things about the tides that cannot be explained by the simple force of gravity.

Around most of the Atlantic, the tides come and go twice a day. But in parts of the Pacific and Indian Oceans, the tide comes in only once a day. At Nantucket Island, off the coast of Massachusetts, high tide changes the level of the water only about one foot. But in the Bay of Fundy, only a few hundred miles north of Nantucket, the water level changes as much as forty feet.

These differences are caused by the irregularities of the ocean floor.

The floor of the sea is not flat, but instead is composed of vast basins, some broader and deeper than others. In these basins the sea water goes back and forth like the water in a dishpan or bathtub when it is disturbed. But water in a bathtub reacts more violently than water in a shallow pan. And, in the same way, the disturbance created by the pull of the moon and sun on the ocean's waters, is always much greater where the ocean basin is deeper.

Souvenirs of the Past

How were sea fossils made?

Five hundred million years ago there was no life at all on the land, only in the warm waters of the seas. And even in the sea there were no types of fishes as we know them today. There were only worms, snails, sponges and primitive crablike creatures.

When these animals died, their bodies sank into the silt and mud of the ocean floor, and the currents covered them up with still more mud. Then, as thousands and millions of years went by, the sea bottom slowly hardened into rock. The bodies of the animals decayed and disappeared, but the remarkably detailed outlines of their forms were preserved forever in the rock.

Trilobite (an extinct sea animal) embedded in rock.

Then pressures from inside the earth gradually bent the layers of rock and lifted them out of the water. They rose up at the rate of one or two inches every few thousand years, and at last became the tops of mountains. And scientists found the fossil remains of the long-dead sea creatures, not on the floor of the ocean into which they had sunk, but on high mountain peaks.

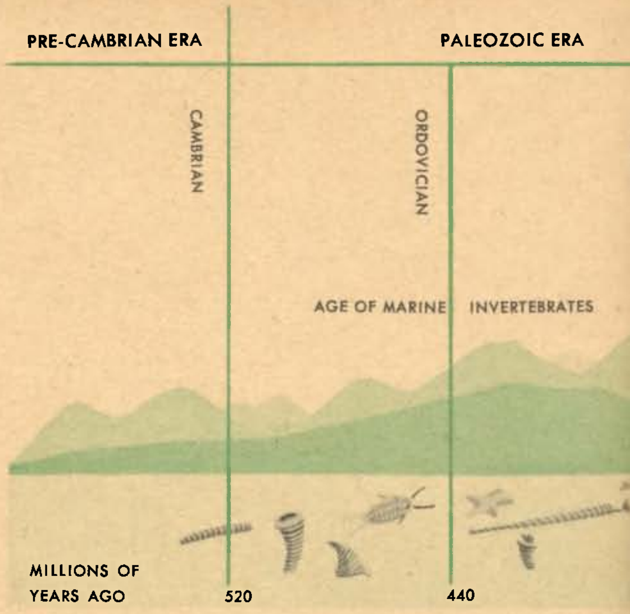
What do we learn from fossils?

It is by studying these fossils of animals and plants that we are able to learn about the kind of life that existed on our earth when it was very young.

By studying fossils, we now know that the first life probably appeared on earth about two thousand million years ago in the form of a kind of algae, the green scum that we often see on the surface of ponds in the summertime.

Then, about five or six hundred million years ago, came the first primitive forms of animal life such as worms and jellyfishes. Following them were the fishes, the first animals with backbones. And then, something like two hundred million years ago, the first amphibians (am-FIB-ians) waddled out of the sea onto the land, developed lungs and legs, and became the first air-breathing animals.

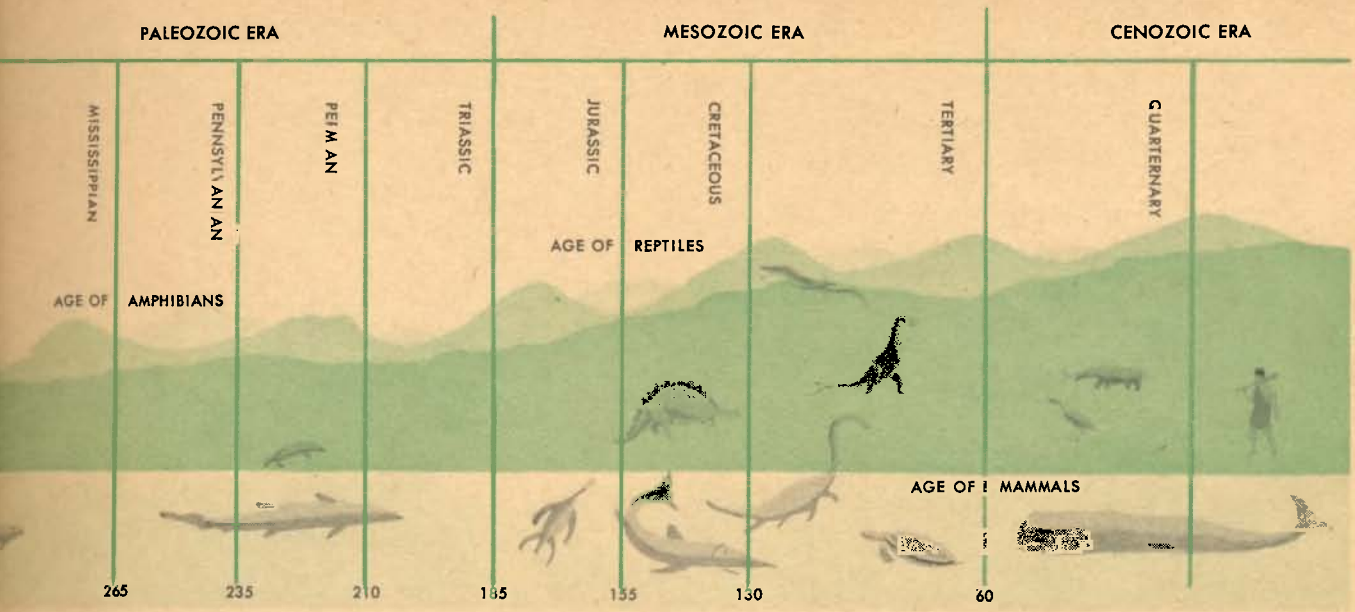
The slow development of life went on — of the reptiles (including dinosaurs) and of the mammals (including man). And the whole story of life is there for us to see and study in the "picture book" of the fossil-bearing rocks.



The ages of the earth are divided into eras of geological history. These eras are further divided into periods which designate the system of rocks formed during each period. The chart above also indicates the form of life dominant in each phase of history.

Has the earth always been the same?

The face of our earth is changing every day, just as it has been changing ever since the dawn of creation. If we look closely, we can see evidences of this ever-present change all around us. After a heavy rain, the water of a stream is muddy. This means that the rain has washed away soil from one place and the stream is carrying it to another. Slowly but surely, the hills through which the stream flows are being worn down and levelled off.



During periods of the earth's geological history, great land masses probably connected (from left to right), Siberia and Alaska, South America and Africa, England and Scandinavia. Fossil evidence supports this.

In the same way, the tumbling waves of the oceans wash away the sands of the beaches and alter the shape of the shorelines.

Again, geologists can read the history of the changing continents in the "picture book" of the rocks.

Fossils of animals that once lived on land have been found at the bottom of the sea. This indicates that these particular sea bottoms were at one time a part of the dry land. And this seems reasonable, since we have learned that the tops of many mountains once lay at the bottom of the sea.

What was the earth like long ago?

A careful study of these fossil clues has given scientists the following picture of what our earth must have been like at various periods of geologic history.

At one time, a bridge of land probably connected northern Europe with Greenland. Another such land bridge possibly extended between Spain and

what is now the eastern coast of the United States. At still another stage in the long history of the changing continents, Africa, Australia and South America were all part of the same mass of land — and forests of fern trees grew across what are today thousands of miles of open water.

Two hundred million years ago, most of North America was under water. Then, as the mountains on the east and west emerged above the waves, a great inland sea covered what are now the midwestern states.

Then, much later, during the Stone Age, many thousands of years ago, the British Isles and the southern tip of Sweden were connected to the continent of Europe. A vast swampy plain filled in what are now the North Sea and the English Channel. The River Thames in England and the Rhine in Germany flowed together to create one mighty stream.

At about this time, too, Siberia was probably connected to Alaska by a land bridge across the Bering Strait. It is believed that early man must have migrated across this bridge from Asia to become the ancestors of the American Indians. Mammoths, the huge, furry forerunners of elephants, apparently took this same route in their travels, for their bones have been found in the American deserts.

What causes a glacier?

A *glacier* is a river of ice that "flows" down a mountainside. Like a river of running water, it cuts out a stream bed for itself and transports vast amounts of rock and soil from the mountain's top and sides to the valley below.

Glaciers are formed in high places where there is snow all the year round. As fresh snow falls and piles up on the snows of previous winters, the snowfield becomes deeper and heavier until the bottom layers are compressed into a sheet of solid ice.

When this huge mass of snow and ice reaches a certain thickness, it breaks away of its own weight and begins to slide, or "flow," down the mountain. Then new layers of snow and ice collect in the crevice made when the glacier tore itself from the mountain wall.

A glacier flows very slowly, usually only a few inches a day. It continues downward until its lower edge reaches a point on the mountainside where the temperatures are warm enough to melt snow and ice in summer. There it begins to melt, and the water keeps going on in the form of streams and rivers.

If a glacier ends at the edge of the sea, large chunks of it break off and become icebergs.

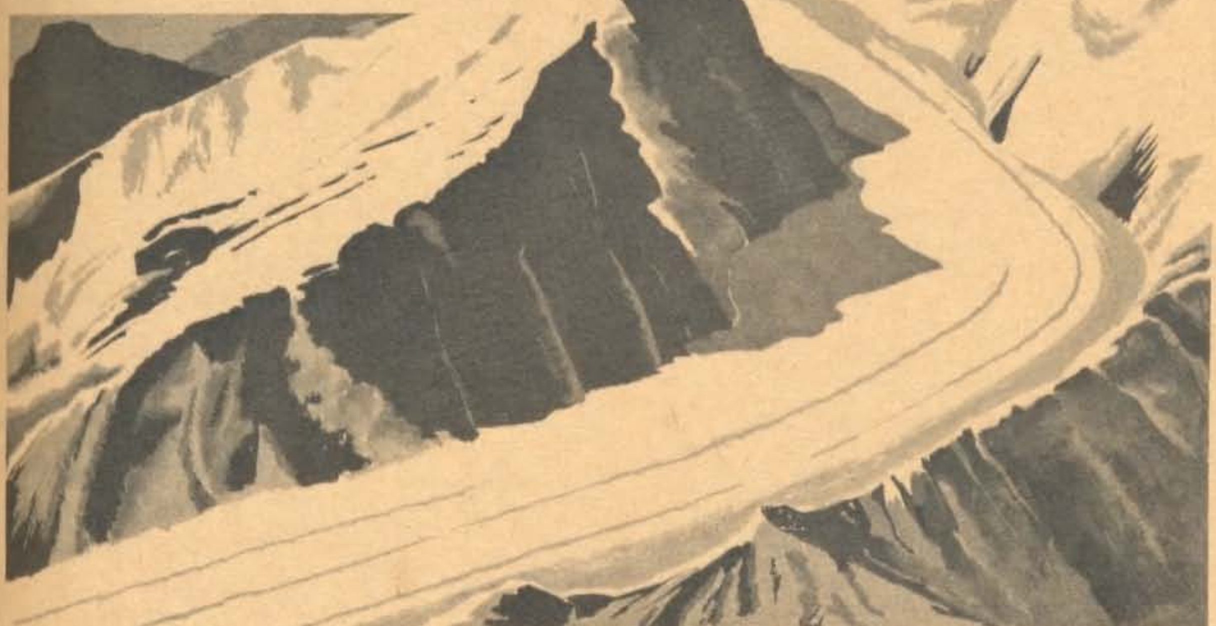
What was the ice age?

Thousands of years ago, a series of glaciers spread southward from the North Pole and buried more than one fourth of the earth's land surface under a crushing sheet of ice. The ice covered all of what today is Canada, all of New England and New York, the entire Great Lakes area and many parts of the western plains.

As the great glaciers slowly advanced, they levelled mountains,

changed the courses of old rivers and created new ones, gouged out the Great Lakes basin and filled the lakes with water as the ice melted and the glaciers finally receded.

They left behind thousands of new lakes, new hills and valleys, and the rock-strewn landscape of New England which marked their lower edge.

Glaciers are bodies of ice moving down mountains or valleys, forming when snowfalls can't melt fast enough.

Water, Water Everywhere

How are rivers formed?

A heavy rain falls on a hillside, and water drips from the leaves of the trees to the ground. There it collects into little rills, or streams, that cascade down the slope. As these tiny streams follow the contour, or outline, of the hill, a number of them merge together to form a larger one. Then this too merges with other flows and at last, all together, they become a small brook.

By the time the water reaches the valley that lies between the hills, hundreds, perhaps thousands, of these little rills and rivulets have flowed together to make a broad river. And now the current slows down, and the river becomes more leisurely and unhurried.

Ever since the water started running down from the hilltop, it has been carrying pebbles and bits of soil along with it. Now, as the river slows down, it may

A river is seen winding down from the mountains.

The heat in the earth from the sun rises at night.

As the sun rises, the soil and the air begin to heat up.

leave some of the heavier part of its load along the way. These deposits of stones and silt often create an obstruction in the river bed that causes the current to swerve to the opposite bank, which it then tends to scoop out.

In turn, this scooped-out bank sends the current back to the opposite side again. And the result is a series of curves that make the river wind from side to side like a giant snake.

The sun's heat evaporates water and forms clouds.

Sometimes rainfalls may be so unusually heavy that the normal river banks cannot contain them. Then the rivers overflow into the surrounding land and cause a flood.

What causes floods?

Floods can be terribly destructive. They often wash away fertile topsoil and may leave the land unfit for cultivation for years to follow. They are dread destroyers of property, sometimes washing away entire towns and taking a horrible toll of human lives.

However, some floods have good results instead of bad. Such an overflowing of water is the annual flooding of the Nile River in Egypt.

Each spring, as regular as clockwork, the heavy rains of central Africa pour into the headwaters of the Nile and cause it to overflow the banks of its lower valley. This great volume of water spreads out over the desert and leaves behind it a rich deposit of soil that has been washed down from the mountains of the interior.

In this fertile coating of soil, the Egyptians grow their crops of cotton, fruit and grain. Then, after a year has passed — after the crops have been harvested and the land has again been baked dry by the torrid desert sun — the floods return to make the earth rich and fertile once more.

Diagram of very fertile land known as a river delta

A great river like the Mississippi pours millions of gallons of water a day back into the sea. This water contains millions of tons of mud and silt and rock fragments which the river has been carrying down out of the land through which it has flowed.

What is a delta?

As the swift currents of the river hit

If cloud is blown to cool place: rain falls; to warm place: moisture is absorbed and cloud disappears.

the heavier, quieter waters of the sea, they are quickly slowed down. As a result, immense quantities of this mud and silt settle to the bottom at the river's mouth to create a wide, flat area of very fertile land known as a *delta.*

The deltas of the Mississippi and the Nile, particularly, are known for the extremely rich farmlands which they have built up over the centuries. And most of the country which is now the Netherlands was built up from deltas of the Rhine and other rivers which flowed from the German highlands down to the North Sea.

What causes fresh- and salt-water lakes?

All of the water in the world moves in a continuous cycle. The sun evaporates it from the surface of the sea. There it condenses and falls back to the earth as rain. And the rainwater flows through rivers back to the sea again.

Some of this water, however, is detoured on its journey and trapped for a time in lakes.

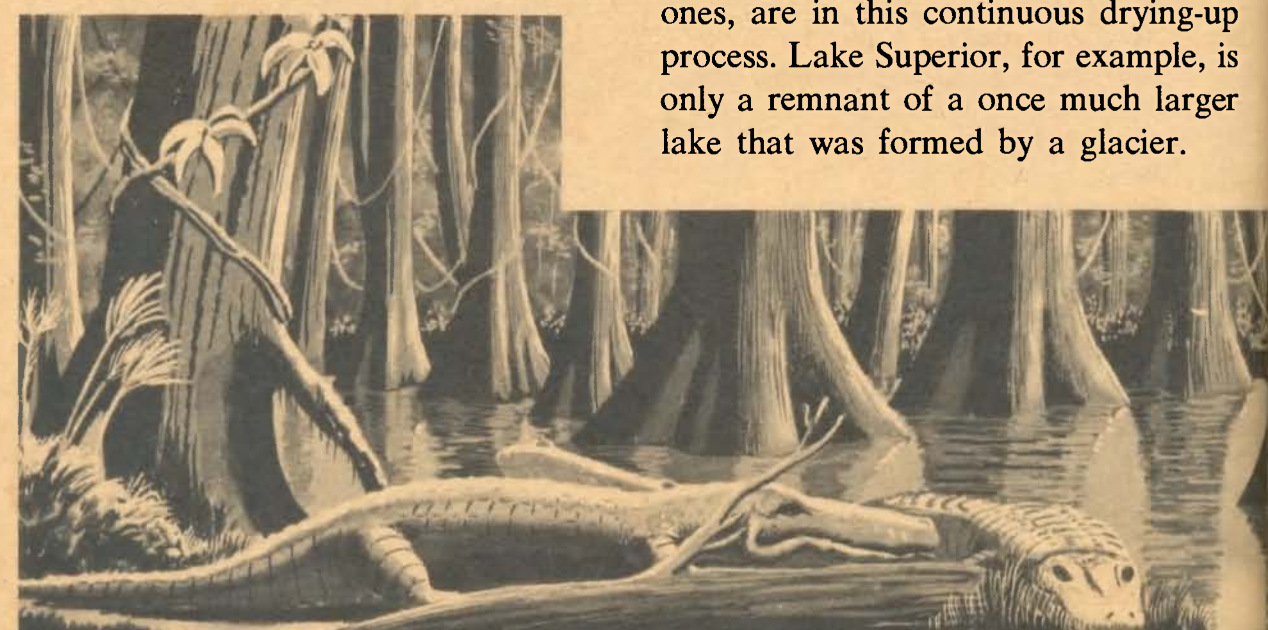
Lakes are fed by rivers, and also drained by them. Where this two-way system of in-take and out-go is working, the water of the lake is as sweet as that of the rivers, and is known as a fresh-water lake. But where there is no outlet from the lake, the water becomes salty.

The Caspian Sea in Asia Minor, the largest lake in the world, is a salt-water lake. So are the Dead Sea in the Middle East and the Great Salt Lake in Utah. The largest fresh-water lake is Lake Superior, on the United States-Canadian border. It is 350 miles long and 160 miles wide. Second in size is Lake Victoria in Africa.

Why do lakes and swamps dry up?

Lakes, as a whole, are the least permanent of the earth's geographic features. Even at the moment they are born, they begin to dry up. All lakes, even the largest ones, are in this continuous drying-up process. Lake Superior, for example, is only a remnant of a once much larger lake that was formed by a glacier.

The Everglades: A great tract of Florida swamp land.



Strangely enough, the rivers that feed lakes and fill them up are also the means of eventually destroying them. As soon as a lake basin is formed, the feeding rivers begin to deposit large quantities of silt and sediment on the lake bottom. Over a long enough period of time, these deposits fill the lake bed completely, turning it first into a swamp and then a meadow. Finally, the last of the water runs off in rivers and continues on its interrupted journey to the sea.

The greatest expanse of swampland in the world, the Florida Everglades, is the remaining part of what was once the ocean floor. The land rose up, and the line of the sea retreated, but not far enough to dry up the area completely.

However, the Everglades are gradually going dry. Parts of them have been drained artificially to create farmlands and townsites, but by doing this, man has only helped to speed up Nature's process. Streams have already begun to take form in the 'Glades, and in time they will serve the same purpose as the man-made drainage ditches. Then, on some distant day, the entire area of the Everglades will be rich, fertile farming and ranching country.

What is quicksand?

Quicksand is a very loose, very light kind of sand which is mixed with water. It is usually found in swamps and other wet places on top of a heavy clay base through which the water cannot drain off.

Quicksand looks like ordinary sand, which is why unlucky animals, and sometimes people, stumble into it by mistake and sink. Unlike grains of ordinary sand, which have angular edges, quicksand grains are round. The underlying water separates them and lifts them up — in a sense, it "floats" them — and thus the sand cannot sustain solid weight. Any heavy object that falls into quicksand sinks as though through water, but much more slowly.

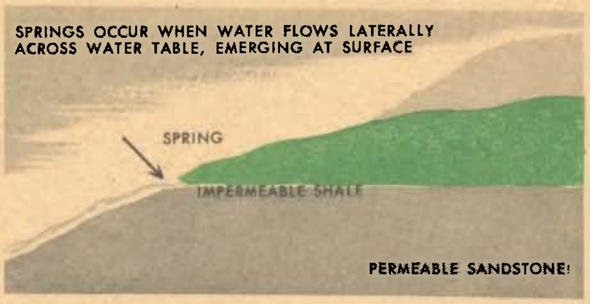
How does water get under the ground?

Every time it rains, a certain amount of rain water is soaked up by the earth. Some of it is held by the soil, and feeds the roots of growing plants. But most of it seeps on down to a level where all the cracks and openings in the underlying rocks are completely filled with water.

Indeed, there is more water under the ground than there is in all the surface lakes and pools.

As a rule, the level of this underground water tends to follow the contours of the earth's surface. For this reason it is possible to get water from a well drilled on top of a hill as well as from one drilled in the valley below.

When the level of this underground water comes into contact with the sur-



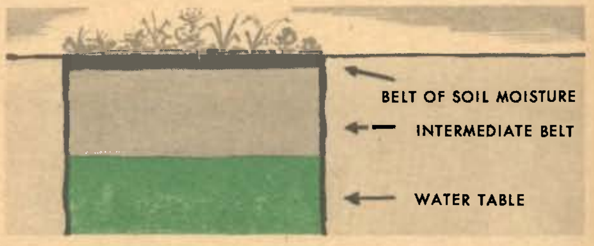
face — usually on the side of a hill — the water seeps out to create a spring. This spring water is cooler and usually tastes sweeter than river water because it has not been exposed to the heat of the sun.

Sometimes a layer of water-bearing rock is encased by strata of solid rock on top as well as underneath. This, then, becomes a sort of natural "water pipe" from which the water inside cannot escape. This water-bearing strata is called an *artesian* (ar-TEE-zhan) *flow.*

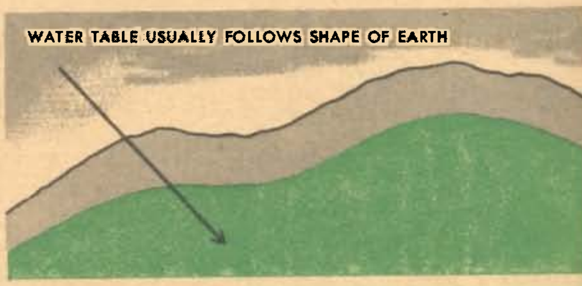
What is an artesian flow?

If a well is drilled down to tap this imprisoned water supply, the pressure from either side will force the water to the surface. If there is a natural crack in the earth, and if the pressure is great enough, the water will gush up like a natural fountain.

Often the water in artesian streams flows hundreds of miles, from the place



where it descended into the earth as rain to the point where it emerges again from wells. For this reason — since they are not dependent upon local conditions of rainfall — artesian wells usually supply an endless source of water, even in times of extreme drought, when other wells in the vicinity go dry.



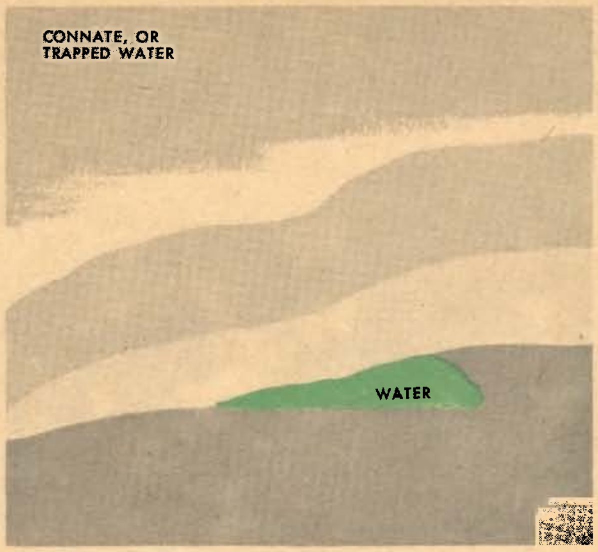
Most underground water, as we have seen, comes from rain that seeps into the earth. But there is still another kind, called *connate* water, that has lain sealed up in pockets of rock deep within the earth for many millions of years.

What is connate water?

When the sedimentary rock forma-

tions were first formed on the bottoms of the ancient seas, a certain amount of sea water was trapped inside of them. Then, when the sea floors rose up and became part of the land, the trapped water deposits rose with them.

A common example of connate water is the salt water that is often brought up from oil wells.



A diagram of a connate, or trapped, water deposit

The Earth's Surface

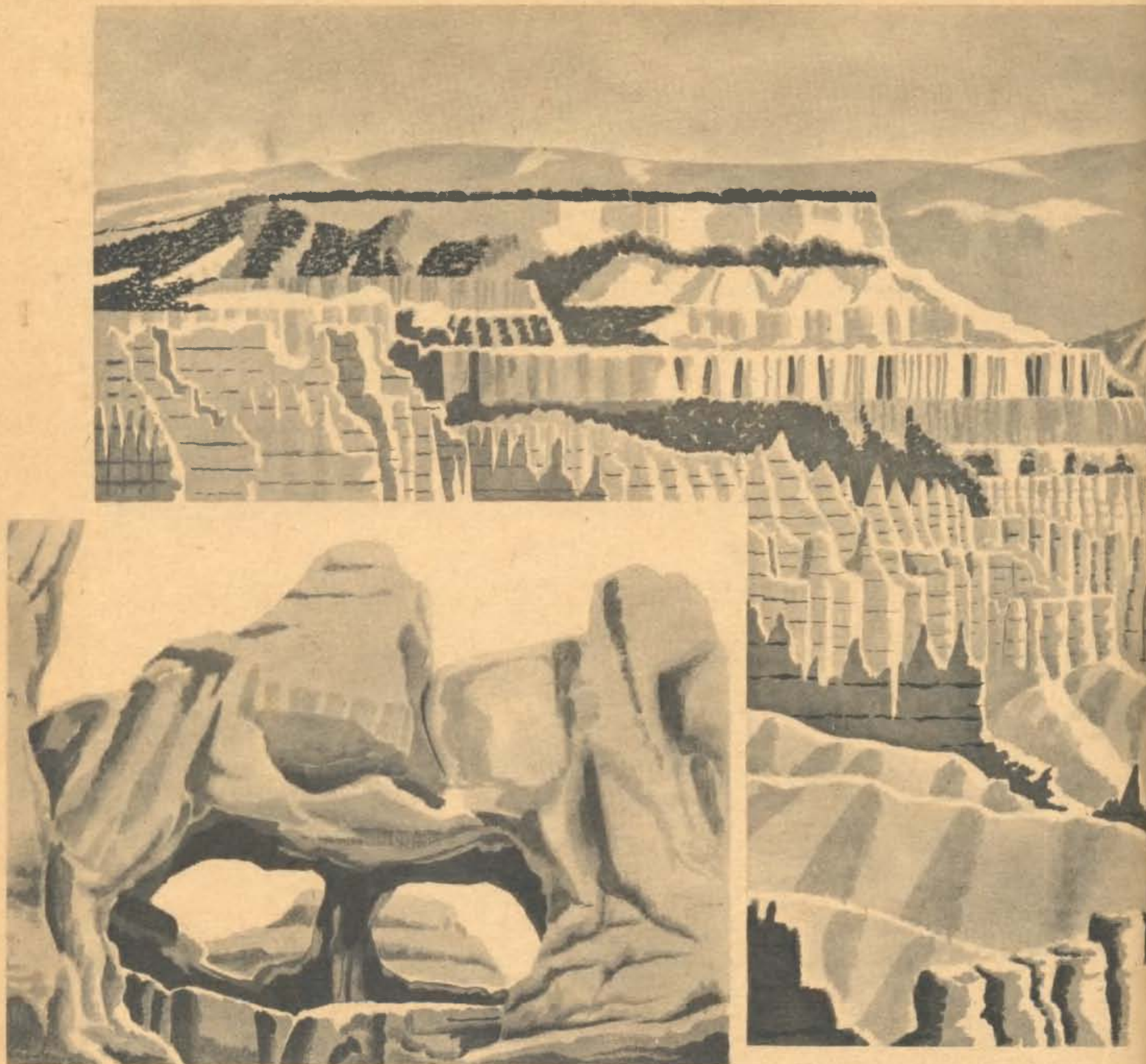
What is a desert like?

When we look out over the dry, waterless desert, it seems to be without life. Except for a few shrivelled scrub bushes and cactus spines, there is almost no vegetation to cover the sandy, rocky ground. In places, the fierce, dry wind has blown the rocks bare of sand and soil, and has cut the rocks themselves into weird, twisted patterns.

By day, the hot, fiery ball of the sun beats down out of the clear, cloudless sky so blazingly that a man could not live for more than an hour or two without some kind of shade. Then, when the sun sinks at last behind the desert's rim, the temperature may drop so sharply that an unprotected traveller is in danger of freezing.

It rarely rains in the desert, and when it does, the rainfall is usually scanty. But on rare occasions a cloudburst floods down without warning from the sky. When this happens, the desert plants greedily drink up the moisture and store it in their long roots, so that it will continue to nourish them during the long, hot dry spell that is sure to follow.

Dunes are sand piles swept together by the wind.

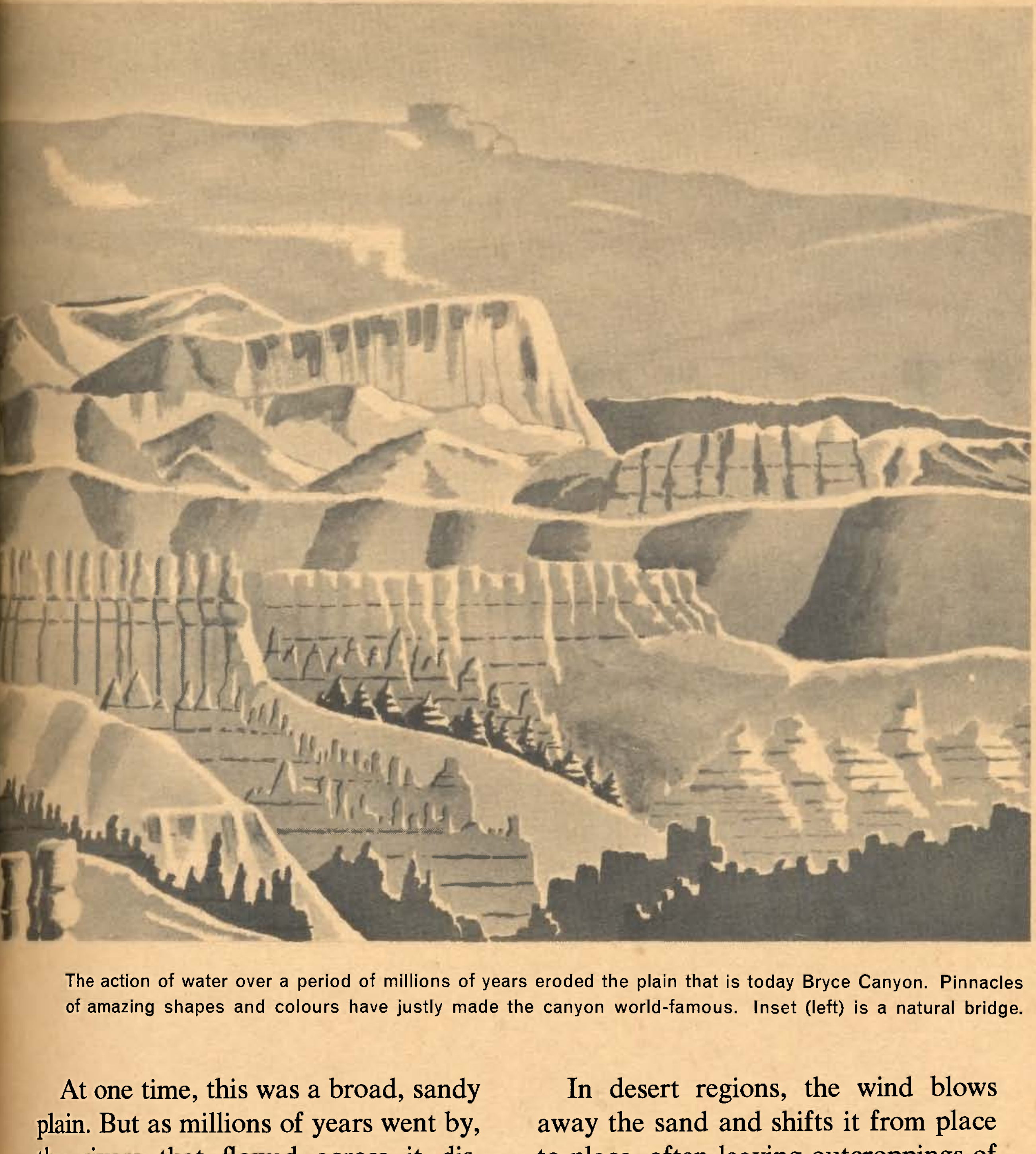


The seeds of the desert plants lie dormant in the dry earth for months, and even years, at a time. Then the magic of the rain touches them and overnight they burst into glorious life, briefly covering the entire desert with a brilliant coat of many colours. Then, just as quickly as they bloomed, they wither and die, waiting, it would seem, for the next rain to bring them back to life again.

How can wind and rain carve rocks?

We know that wind and water are constantly at work reshaping the surface of the earth. Perhaps the most unusual examples of this erosive action can be found in the deserts of the American West.

The strange rock formations pictured here are in Bryce Canyon National Park, in Utah.



The action of water over a period of millions of years eroded the plain that is today Bryce Canyon. Pinnacles of amazing shapes and colours have justly made the canyon world-famous. Inset (left) is a natural bridge.

At one time, this was a broad, sandy plain. But as millions of years went by, the rivers that flowed across it dissolved the limestone in the underlying rock and ate away the harder rocks bit by tiny bit — until, at last, Bryce Canyon became the place of fairyland palaces and monuments that it is today.

The action of the wind is nearly as important in the reshaping of the land as that of water.

In desert regions, the wind blows away the sand and shifts it from place to place, often leaving outcroppings of bare rock. Then the wind-blown sand is blasted against the rock with the same effect that sandpaper has when you rub it across a piece of wood. Gradually the rock is worn away — the softer parts going first and the harder parts remaining. The results are often such odd and beautiful pieces of wind-

and-sand sculpture as natural rock bridges or balanced rocks that look like giant tops.

We have seen that the forces of nature are constantly at work changing the surface of the earth. Man has also done his share to alter the appearance and characteristics of parts of the land. Sometimes, as in the instance of the area in the Southwest of the United States which was appropriately called the Dust Bowl, this has had very tragic effects.

How has man helped to change the surface of the earth?

At one time, this part of Texas and Oklahoma was a lush grassland. The thick grass roots held in the moisture of the soil, and even in times of drought the land was green and fertile.

Then farmers began to plough up the grasslands to plant crops. And in the early 1930's, there came a long dry spell. The crops failed, and the loose soil, with no grass roots to hold it together, began to blow away in vast dust storms.

For many years, the land produced no crops, and most of the people who lived in the area left it and moved to other parts of the country.

The use of irrigation ditches in sandy, barren stretches of land has resulted in productive farmland acreage.

Gradually, however, the people who stayed on the land began to plant it again with grass. And the farmers learned how to plant their crops in such a way that the soil could be conserved. Today, what was once the Dust Bowl is again prosperous farming and grazing land.

How can a desert be made to bloom?

Sometimes, unlike what happened in the Dust Bowl, man has often changed the face of the land for the better. There are many parts of the world where early settlers have made their homes in dry, arid deserts where nothing could grow but cactus and other desert plants useless to man.

By digging irrigation ditches and bringing in water from distant rivers, farmers changed the earth from unproductive desert sand to fertile soil. And today, large areas of what once were deserts, have become most fruitful farmlands.

What rocks make up the earth's surface?

Basically, there are three kinds of rocks that make up the earth's surface.

1. *Igneous* (IG-nee-us), meaning "fire." Igneous rocks are the oldest, since they were formed from the hardening of molten magma when the earth first began to cool and solidify millions of years ago. Thus they were the ancestors of the other two rock types, as well as of all sand and soil.

The two most common and most important igneous rocks are *granite* (GRAN-it) and *basalt* (ba-SALT).

Granite is an igneous rock (formed from fire or heat).

Basalt is another igneous rock of volcanic origin.

Granite is the most widely used building stone because of its strength and endurance. It ranges in colour from white to grey to green to pink to red.

Basalt, sometimes called traprock, is the stone that is most usually crushed and used to make surfaces for roads. It varies in colour from grey to black.

2. *Sedimentary* (sed-ih-MEN-tary), meaning "a settling." Sedimentary

rocks are composed of what at one time, many millions of years ago, were layers of sand, gravel, mud and sediment lying on the bottoms of ancient seas. These materials were hardened into true rock by the great pressures that were exerted upon them.

The most common sedimentary rocks are sandstone, limestone and shale.

3. *Metamorphic* (met-a-MORE-fik), meaning "made over." Metamorphic rocks are those which at one time were either igneous or sedimentary, but which were changed into a different form by forces such as heat and pressure which came from deep within the earth.

The metamorphic rocks we most frequently see are marble, slate and quartzite.

Marble, one of the hardest of all stones, was "made over" from limestone, one of the softest. It is widely used for monuments and building.

Slate was "made over" from layers of compressed shale and clay. This strange rock splits easily into thin, uniform sheets with a smooth, straight surface. It is commonly used as roofing material for houses.

Quartzite (KWORTS-ite) looks a great deal like sandstone, from which it was "made over." But while sandstone is relatively soft, quartzite is among the hardest of rocks. An outcropping of quartzite often takes the form of a cliff, from which the softer rocks have been eroded away.

Here are some unusual kinds of rocks.

Asbestos, a mineral, is found in metamorphic rocks in the form of long silky fibres. These fibres can be woven into a fireproof cloth that is used to make brake linings and fire-fighting clothing.

Flint was used by early primitive man to make his knives and arrowheads.

Pudding stones are odd-looking stones most usually found in the beds of streams. They are a form of sandstone in which small pebbles, rock fragments, fine sand and various other rock-forming minerals have all been mixed up like a pudding and cemented together in a solid mass.

Petrified wood, found in the Petrified Forest of Arizona, is not really a piece of wood that has turned to stone. What actually happened was that millions of years ago, a tree fell into a swamp where the water contained a high proportion of dissolved quartz, one of the rock-forming minerals. The water soaked into the cells of the wood, and as the wood decayed, the quartz hardened to form the same pattern as the fibres of the tree.

What are minerals?

In general, a *mineral* may be defined as any solid element or compound that is made up of chemical substances found in nature.

For example, common table salt — known as halite (HAL-ite) is composed of sodium and chlorine. A diamond is formed from carbon, which is also the basic ingredient of coal. Rubies and sapphires come from corundum (cor-UN-dum) which, in another form, is the rough, black rock that is used to make grindstones.

Rocks

SANDSTONE

SHALE

SLATE

LIMESTONE

MARBLE

QUARTZITE

FLINT

PUDDING STONE

TALC

Minerals

HALITE

CRYSTALS OF SULPHUR

HEMATITE

CORUNDUM CRYSTAL

RHODONITE

FLUORITE

All rocks are made from a great many kinds of minerals, and when you break open a piece of rock, you can see these minerals — like quartz and mica — usually in crystal form.

Here are some common minerals that you might find in rocks around your home.

Quartz is probably the commonest of all mineral crystals. It is found in all sizes — some long and slender, some thick and squat — but all quartz crystals have identically the same shape. They are six-sided prisms, with six-sided pyramids on the top and bottom. Quartz is one of the hardest of all minerals. It cannot be scratched with a knife, but it will scratch or cut glass. Quartz sand is the basic ingredient in glass-making.

Mica (MY-kuh) is found in granite and other igneous rocks. It can be split into paper-thin sheets that are transparent, flexible and fireproof. It is used to make the little windows in electric fuses and the larger windows in oven doors. In some primitive countries, it has been used as window glass.

Talc is a curious white mineral so soft that you can scratch it with your fingernail. It feels greasy to the touch. It is used commercially as a lubricant, and as the base for talcum powder.

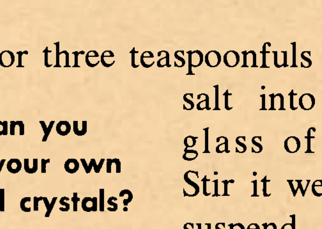
Calcite (KAL-site) is a common mineral that is found in a number of forms. It may appear in thin sheets, like mica, or in diamond-shaped crystals, like quartz. You may sometimes find a crystal of calcite that is as transparent as glass, but the curious thing about it is that when you look through it you see everything double. If you break a calcite crystal with a hammer, each tiny fragment will be a perfect little six-sided shape with smooth surfaces and equal angles.

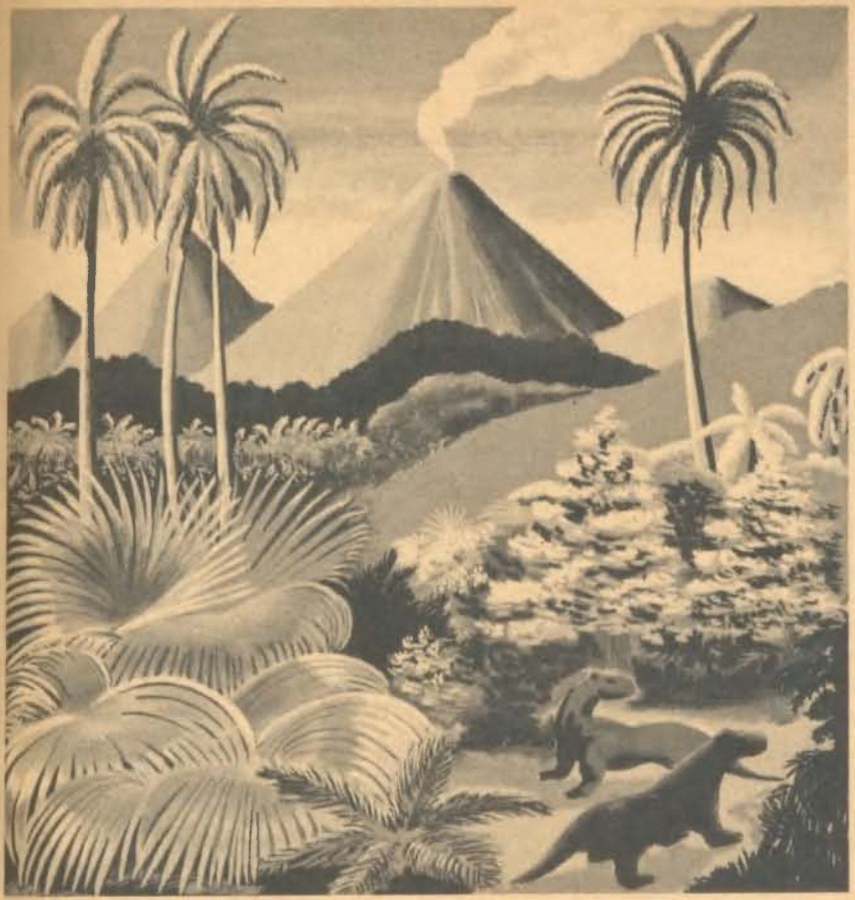
Amber is not a true mineral, since it is the fossilized remains of the resin of ancient fir trees that fell into swamps. But it is an interesting mineral-like substance to examine. Quite often the bodies of insects that were trapped in the resin when it was liquid, thousands of years ago, are still perfectly preserved.

Pyrite (PIE-rite) is known as "fool's gold" because it fooled so many miners in the Old West into thinking that they had found a gold mine. Pyrite, a beautiful, sparkling mineral, is often used to make ornaments and jewelry.

How can you make your own mineral crystals?

Put two or three teaspoonfuls of table salt into half a glass of water. Stir it well. Now suspend a piece of string into the liquid from a stick laid across the rim of the glass. Put it away in a cool place for several days. At the end of that time, the salt will have formed crystals on the end of the string in the shape of little cubes of pure halite that sparkle like a cluster of miniature diamonds.





An ancient forest scene

Treasures in the Ground

How was oil made?

About three hundred million years ago, great forests of tree ferns covered the hot, swampy earth. As they wilted and died, they tumbled into the swamps, and there they sank down into the ooze. As thousands of centuries crept slowly by, the buried tree ferns were covered up by other ferns and trees that fell into the water on top of them.

Then the face of the earth slowly changed, and the swamp was covered over with silt which turned to rock. And at last the land sank down and was swallowed up by the waters of the seas. More millions of years passed, and the land rose up from the sea bottoms again to form hills and plains and plateaus. And what had once been the tree-filled swamps were now imprisoned between thick layers of rock thousands of feet below the surface.

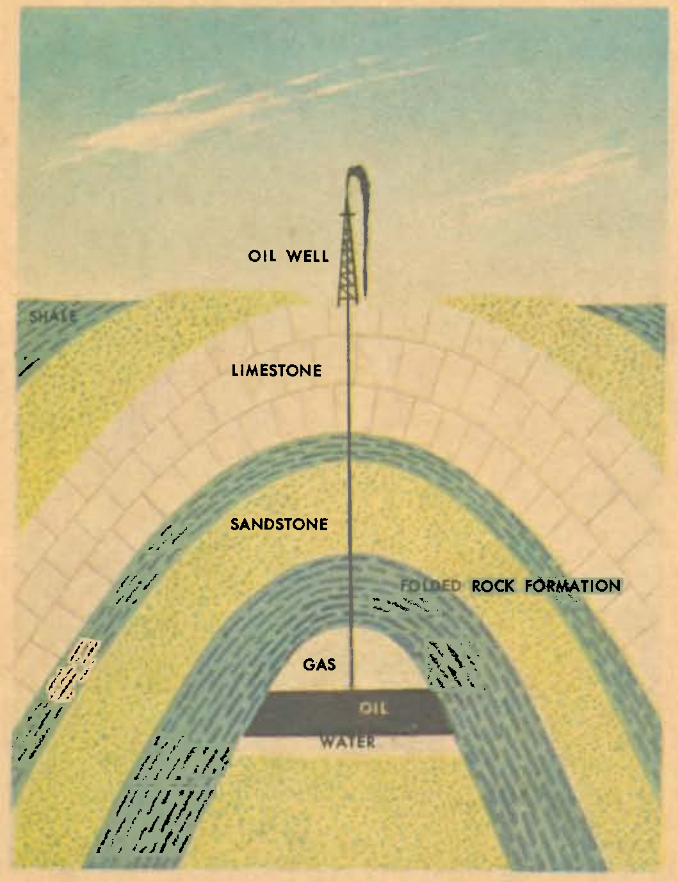
But while all this land-change had been going on, a curious thing had been happening. Pressures from inside the earth had brought about a chemical change in the masses of trees and ferns and other vegetable matter that had sunk into the original swamps so many millions of years before. Now it had been changed into an underground reservoir of the thick black liquid which we call petroleum, or crude oil.

Sometimes these underground deposits came close enough to the surface so that the oil seeped up and formed black, sticky puddles. And the ancient

people used this crude oil for lights and cooking fires.

It was not until about a hundred years ago, that scientists learned to drill for petroleum and refine it into such products as petrol, paraffin and lubricating oil. But in the modern world, it has become our most important fuel. Without it, we could not operate our cars or ships or factories or power plants.

Oil deposits are usually trapped under the ground between layers of folded rock. The petroleum floats on a pool of connate water, with a pocket of natural gas on top. When a well is drilled down to the oil deposit, the pressure of the gases forces the petroleum to the surface.



This is a cutaway view of an oil deposit in the earth.

This is a fossil leaf which has been embedded in coal.

How was coal made?

Coal was formed in much the same way as oil, and at about the same time in the earth's geological history. Vast masses of vegetable matter fell into ancient swamps, rotted, were covered up by mud and silt which turned into stone, sank into the sea and then rose up again.

But in some strange way, these rotted tree ferns and mosses, instead of changing into liquid oil, had been subjected to different kinds of forces which transformed them into the hard, black, brittle rock which we call coal.

Coal lies under the ground in long, thick seams, sandwiched in between layers of slate or shale. Sometimes, when a piece of coal is broken open, the fossil imprint of a fern leaf can be clearly seen, still as perfectly shaped as when it grew upon the ancient tree.

Why are iron and steel important?

Iron is perhaps the world's most important mineral. From iron we make steel, and from steel we make most of the necessary things that we use every

day — buildings, motor-cars, ships, trains, tools, machinery, stoves, furnaces, refrigerators. A day never passes during which we do not depend upon some article made of iron or steel.

Although iron was one of the most abundant elements from which our earth was made — and though the earth's central core is almost pure iron — iron practically never occurs in its pure state on the surface where man can get at it. Instead, iron is mixed with other minerals in the form of *ore,* and the ore itself is imbedded in the rock of the crust. Extracting it is a long and difficult process.

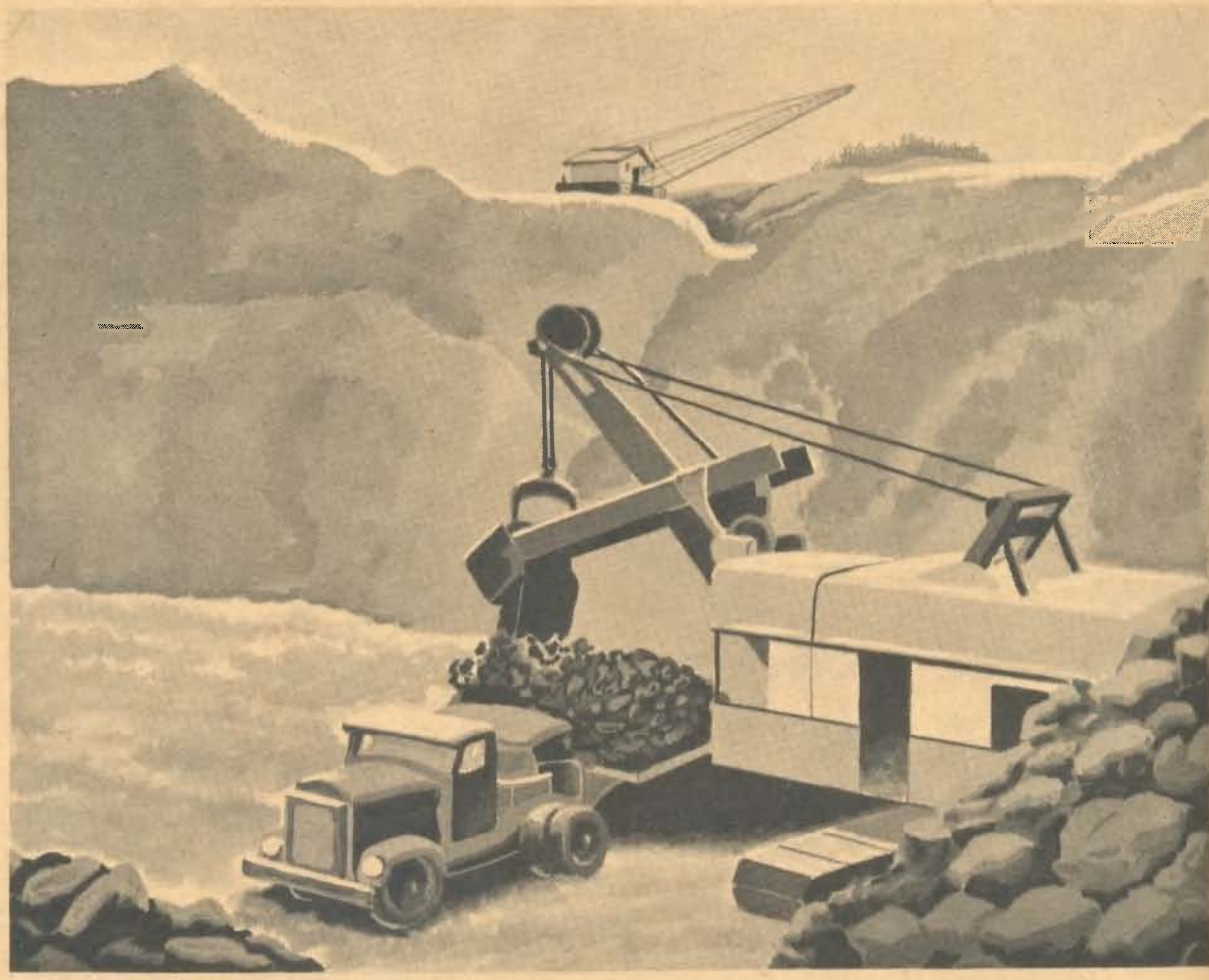
There are deposits of iron ore all over the British Isles. When the ore lies near to the surface, it is scraped out of great open pits by steam shovels. If it lies deeper, shafts are dug and the ore is mined like coal.

The ore is converted to steel in great mills. Sheffield is Britain's most famous steel-production centre.

How are other metals useful to us?

Next to iron, copper is our most useful metal. It is essential to the manufacture of electrical equipment, and has many other uses as well. Combined with zinc,

Bessemer converters shown in operation in a steel mill. In the process, steel is manufactured from cast iron.



Bauxite, from which aluminium comes, is mined here in open-pit. France and the U.S. lead in its production.

it becomes brass; and when tin is added, it becomes bronze.

There is even more aluminium than iron in the great mass of minerals that make up the earth's crust. But most of this metal is tightly imprisoned inside certain rocks, and there is no practical method by which it can be extracted.

However, under certain conditions, these rocks have weathered and broken down into a claylike mineral called *bauxite* (BAWK-site). And it is from this bauxite clay that we get all of the aluminium which we use in industry.

Aluminium is a very light, very strong metal. It is used where lightness is as important as strength, such as in the manufacture of airplane bodies and motors, household furniture and kitchen appliances, scientific instruments and certain kinds of machinery.

There are a great many other metals that play an important part in our daily lives.

Tin is chiefly used to put a protective coating over steel so that the food in "tin cans" will not spoil.

Chromium (CRO-mee-um) is mixed with steel to produce the alloy called "stainless steel," which is used for automobile trimming and other products that require extreme hardness, plus resistance to rust.

Gold, which we consider to be the

"most precious" metal, is used for money and jewelry, but has little use in industry.

Silver is also used for jewelry, and for fine tableware. It is the best known conductor of electricity, and is therefore used in the very finest electrical equipment.

Uranium (u-RAY-nee-um), the "miracle metal" of modern times, is our chief source of atomic power. It is found in many kinds of rocks, such as uranite, carnotite, davidite and gummite.

What are the "precious" minerals?

Since earliest times, people all over the world have treasured rare and beautiful mineral stones as their most prized possessions. The most precious of these gem stones are diamonds, emeralds, rubies and sapphires.

Diamonds are the hardest of all stones. A diamond will cut any other known substance, but the only thing that will cut a diamond is another diamond. Most diamonds come from Africa, but they are found all over the world. There are diamond mines in India, South America and the United States. The largest diamond ever found, the Cullinan, was discovered by a farmer in South Africa who happened to see a shiny stone sticking out of the ground. It was about the size of a man's fist and was cut up to become part of the British Crown Jewels.

Emeralds, if they are large and have no flaws, are worth more than diamonds. Most of them come from Ecuador, Peru and Colombia in South America. True emeralds are a deep green in colour.

Rubies, at least the finest ones, come from Burma. The most valuable of these fiery red stones are known as "pigeon blood" rubies, since from ancient times the standard of perfection has been to compare the colour of the stone to that of a drop of blood from a freshly killed pigeon.

Sapphires are found in many hues and colours, but the most valuable are those of a deep cornflower blue which seem to glow with an inner light that takes the form of a star. These are known as "star sapphires."

What are some common gem stones?

In addition to the really precious gems, there are a great many beautiful gem stones that any boy or girl might find not far from home. Some of these are:

Aquamarine, a lovely bluish-green stone that is usually found embedded in rock ledges.

Amethyst, a delicate purple stone found in the Highlands of Scotland, ordinarily in clusters of small crystals.

Agate, a form of quartz that has concentric (circles one within another) layers of different colours. When cut and polished, agate makes jewellery of gleaming beauty.

Clear Quartz. Sometimes one is lucky enough to find a quartz crystal with a hollow cavity inside that contains a drop or two of water. This water somehow became imprisoned inside the stone when the crystal was formed, and since it cannot evaporate, it will remain there forever.

Gem Stones

OPAL

EMERALD

STAR SAPPHIRE

ALEXANDRITE

DIAMOND

AQUAMARINE

TOURMALINE

RUBY

GREEN PERIDOT

TOPAZ

JADE


CARNELIAN


MOSS AGATE


STEATITE


LAPIS LAZULI


PEARL


AMETHYST


BERYL


MALACHITE


TURQUOISE


ONYX


CHRYSOBERYL

Chalcedony, the smooth, round, semi-transparent pebbles that are often found on beaches or along the banks of streams.

Garnet, another stone that is found in the Scottish Highlands. Most are brownish in colour, but the most prized stones are deep, clear red or emerald green.

Sun Stone. Tiny specks of mica imbedded in clear quartz crystal give this unusual stone the appearance of flashing sparks of fire from deep inside.

The Underground Rooms

Of what is the soil made?

The thin layer of soil that covers most of the surface of the earth nourishes all of the life that exists on land. Without it, no grass or grain or vegetables could grow to furnish food for animals and men.

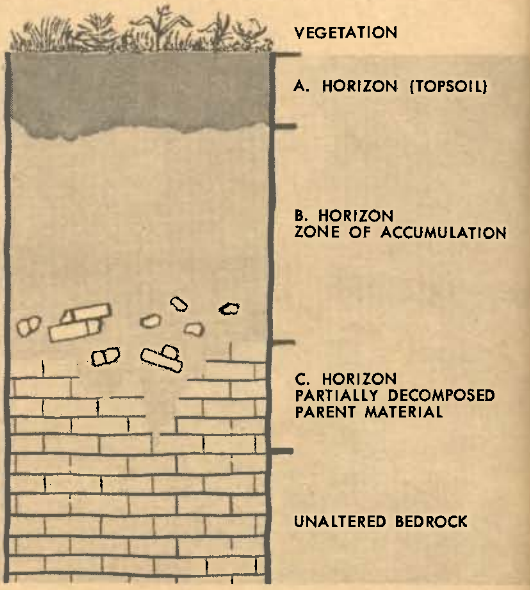
Soil is a combination of decaying rock and decaying vegetable matter. The hot summer sun heats bare rock and expands and cracks it. The ice and snow of winter contracts and splits it. Rain washes tiny grains of the weathered rock into small depressions of the ground. Here the rock particles mingle with dead leaves and decaying plants — and the two form the carpet of soil that covers the earth's floor.

You can prove this by dropping a handful of soil from a garden into a glass of water. Stir it up, and then allow it to settle. Some particles will float to the top. The rest will sink to the bottom. If you examine the floating particles, you will see that they are small bits and pieces of leaves and roots and other vegetable matter. The particles that sink are bits of sand and gravel, remnants of the weathered and broken-up rock.

During most of the earth's lifetime, it had no soil. There was nothing on the face of the land but barren rock. Then tiny plants from the sea water, called lichens, began to grow on rocks at the ocean's edge. Their little roots penetrated the rocks' surface and caused bits of it to scale off. Then, as the lichens died and decayed, they mingled with the rock dust and gradually began to turn into soil.

More plants grew, and they in turn became part of the soil. And in this way the carpet of soil began creeping inland from the seashores until it had covered most of the earth's land.

The soil is divided into three layers.



This interior of a cave shows stalactites extending from the ceiling and stalagmites rising from the floor.

The bottom layer is solid bedrock, with its upper edges slowly decomposing, or decaying, and flaking off.

The middle layer is hard-packed, and contains rock fragments and pebbles mixed with clay and heavy earth. Minerals seep down into it from the surface, and up from the ground-water that lies underneath. Only the roots of trees and larger plants penetrate this middle layer.

The top layer is the part of the soil in which we plant things. It is soft and crumbly, and is composed sometimes almost entirely of decayed vegetable matter. This layer extends down for only a few inches.

And yet, in this thin layer of topsoil, an amazing amount of plant and animal life is present.

How were caves formed?

A cave is the nearest thing in Nature to a fairyland world. Fantastic icicles of stone hang from the roof of a cave in a million shapes and sizes. Tapering stone spires rise up from the floor and stone flowers, with delicately coloured petals, grow in cracks between the rocks.

Caves are usually found in those parts of the world where the underlying rock is limestone. The chief part of limestone is the mineral *calcite,* and this is readily dissolved by the small amount of *carbonic acid* that is present in most surface water.

A cave has its beginning when rain-water seeps into the ground and flows between layers of limestone. As the water passes, it dissolves tiny parts of the stone and carries the dissolved material along with it. This ceaseless weathering of the rock by the water continues for countless thousands of years. The pathways that the water has cut out for itself are enlarged, until at last the underlying rock is filled with passageways that wind and twist down through the rock layers, and sometimes widen and spread out to form huge underground rooms.

What are stalactites and stalagmites?

When ground water seeps down through the earth, it reacts upon the limestone over which it passes to form a mineral called *calcium bicarbonate*. As this water slowly filters through the ceiling of the cave, drop by single drop, each drop clings to the ceiling for a moment or so before it drips to the floor. But in that short moment, a slight amount of evaporation takes place, and when the drop of water falls, it leaves behind a tiny amount of calcium bicarbonate.

After many centuries, these tiny deposits build on each other and eventually form a stone "icicle" that hangs down from the ceiling. This is called a *stalactite* (stal-ACK-tite).

When each drop of water falls to the floor beneath the stalactite, it splashes and leaves another small deposit of calcium bicarbonate. These deposits gradually build upward, and form a stone pillar rising up from the floor, which is called a *stalagmite* (stal-AG-mite).

In the course of a long time, the stalactite hanging down may unite with the stalagmite protruding upward to form a *column*. Sometimes a number of these columns join together and divide the cave into rooms.

Still another kind of mineral "growth" found in caves are the beautiful and delicate clusters of *helictites* (hel-ICK-tites). These are formed, like stalactites, by the gradual evaporation of water. But no one knows quite how they achieved their fantastic shapes.

What are wind caves?

The most common type of shallow caves are formed on the sides of hills or rocky cliffs by the action of the wind. This happens when a layer of soft rock, such as shale, is sandwiched in between two layers of hard sandstone. Wind currents swirl across the face of the hillside and scoop out particles of the shale, often digging quite far back into the mountain.

These are the caves most often used by ancient cave men for their homes, and by wild animals for their lairs.

Often the rolling waters at the base of a waterfall dig out a cave under the overhanging rock. The most famous of these waterfall caves is known as the Cave of the Winds, beneath Niagara

Interior view of an ice cave

Falls. Visitors are taken into it, and there they can stand behind the huge pounding wall of water that roars down from the river above.

What are ice caves?

Some of the most fantastic caves in the world are the ice caves of the European mountams. Ages ago, when the earth's climate was much warmer than it is now, underground rivers tunneled their way through the solid mountain rock. Then the long ice age descended on the Northern Hemisphere, and these rivers froze in their underground beds. Today, they exist as caves of ice.

In places, far under the mountain tops, these ice rivers flow into ice lakes that are as smooth as skating rinks. Sometimes they drop suddenly over a precipice to create solid waterfalls of ice that are nearly half as high as Niagara Falls.

In the open corridors of the caves, columns of ice rise up from the floor like crystal stalagmites. These were created by the slow dripping and refreezing of melted ice falling from above. Now and then these columns fuse together to form delicately sculptured ice curtains.

Often stalactites of ice hang suspended from the ceiling, so crystal clear that they can act as a gigantic magnifying glass. Occasionally, bubbles of air, imprisoned in a stalactite when it froze, give the huge formation the quality of a gleaming jewel.

What are underwater caves?

Since limestone caves were created by the action of underground water, it is not surprising that many such caves are completely flooded. One of the most amazing of these underwater caverns is Wakulla Cave in Florida.

Wakulla Spring, source of the Wakulla River, is a small lake that is fed entirely by underground water. For many years, scientists had wondered about the source of this water. And so a group of geologists, equipped with skin-diving gear and other equipment, set out to explore it.

They found that underneath the surface of the spring, the cave slanted sharply downward to a depth of nearly 200 feet, and there it began to level off. Its width varied from 70 to 150 feet — and its height, from floor to ceiling, was in places only 5 feet and in others more than 100. The floor was of sand, with patches of clay and limestone rubble.

The divers explored the cavern for a distance of 1,100 feet from the entrance. Here the bottom dropped down sharply into a much wider and deeper section of the cave, but beyond this point the divers could not go without running short of air.

It is believed, however, that Wakulla Cave may extend for several miles to the source of its water supply.

The Beginning of Man

What were the cave men like?

It is only natural that early man should have lived in caves. He had neither the tools nor the skills to build houses — and hillside caves provided ready-made shelters from cold, snow, rain and wild beasts.

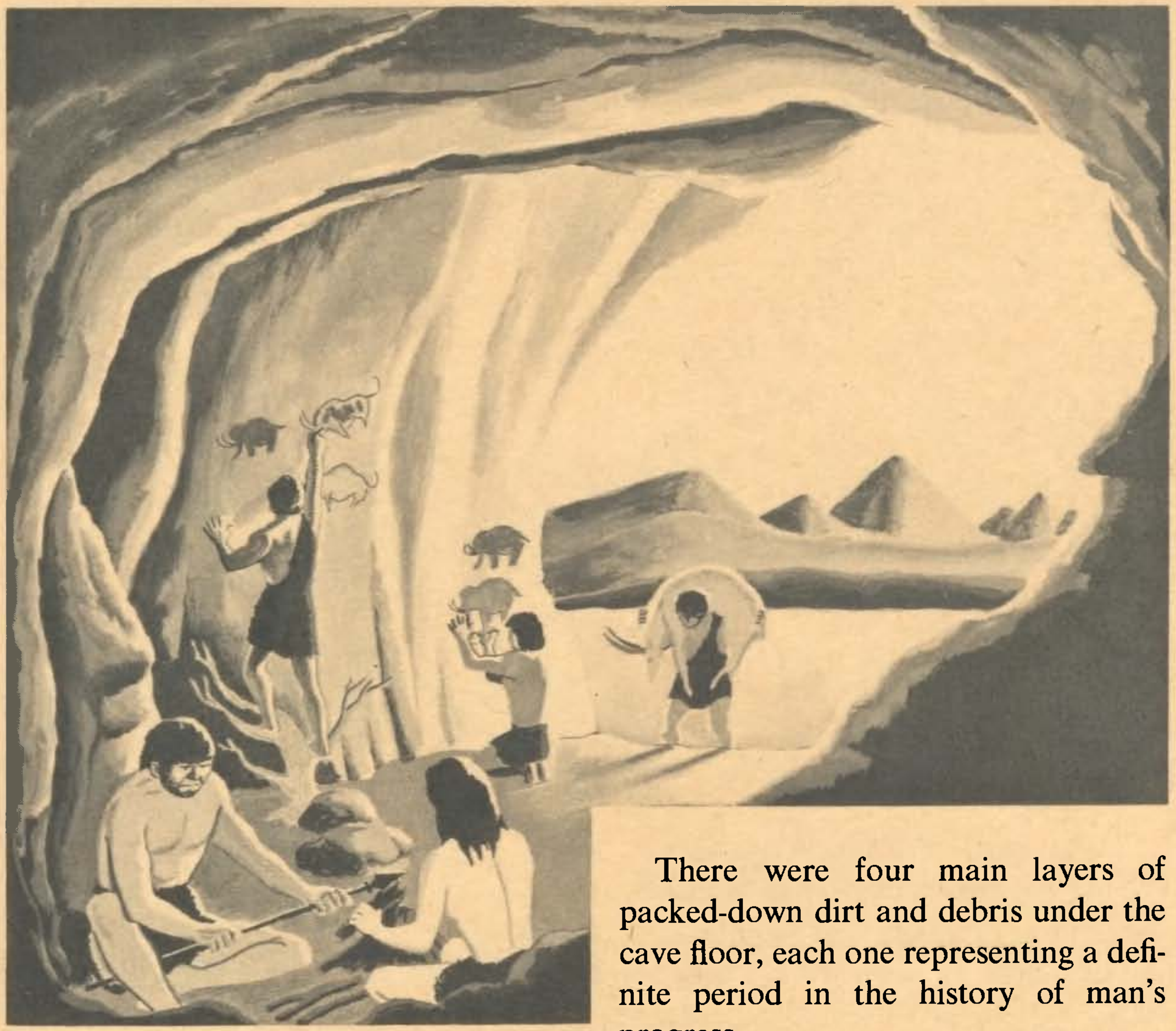
As nearly as we can determine, man has been living on the earth for about half a million years. Evidence recently dug up in caves has definitely traced his history back to about 100,000 B.C.

One hundred thousand years ago, man didn't look very much as he does today. He was generally short and squat, with stubby legs and long, thick arms. Most of his body was covered by a heavy mat of hair. His only tools were hatchets and knives made of flint, and he was just learning to use fire to warm his cave home. He was also just learning to speak.

How did we learn about the cave men?

A few years ago, a team of American scientists found a cave in the mountains of Iraq that contained a continuous history of human progress from the Stone Age to the present day. This was Shanidar Cave.

Shanidar is inhabited today by a tribe of Kurdish peasants, but the amazing thing about this cave is that it has



Early man lived in warm and protective caves.

been lived in by humans for about one hundred thousand years!

Luckily for the scientists, the tenants of the cave, from earliest times, were very untidy housekeepers. Instead of sweeping out their trash and refuse, they simply buried it under succeeding layers of dust and dirt. So by digging down into the floor of the cave, the researchers were able to lay bare a cross section of human history — in much the same way that the fossils in layers of sedimentary rocks give us a picture-history of the earth itself.

There were four main layers of packed-down dirt and debris under the cave floor, each one representing a definite period in the history of man's progress.

The top layer dates from the present time to about seven thousand years ago. Here were found pieces of pottery, stones for grinding grain, and the bones of domestic animals—evidences that man was learning to grow his own crops and tend his own herds.

Below this was a layer said to be some twelve thousand years old. There was no indication here that the people of this period knew anything about farming or the care of animals.

The third layer went back in time to about 40,000 B.C. Yet in all of the thirty thousand years that had passed between the laying down of this layer

and the one above it, there was no evidence that man had made much progress in his way of living.

Finally, the fourth and last layer of the debris on the floor of Shanidar Cave takes the history of mankind back to its earliest beginnings, about one hundred thousand years ago.

It is from such bits and pieces of evidence as this that we are able to put together a picture of the life of primitive man at the dawn of human time.

Who made the cave paintings?

One day, about a hundred years ago, a little girl and her father were exploring a cave in Spain. As the father was examining ancient flint hammers and arrowheads which he found on the cave floor, the child wandered off into another room carrying a candle to light her way.

Suddenly she looked up to the ceiling of the cave and screamed:

"Bulls! Daddy! Bulls! Come quick!"

Her father came running, and when he reached her, he saw an amazing sight.

There on the ceiling and walls of the cave were the pictures of animals.

Who painted them? Why did the primitive artist paint them in a cave? How did he get light to see by?

Nobody yet knows the answers. All that we know for sure is that the paintings were done by an unknown Stone Age genius about twenty-five thousand years ago.

An unknown Stone Age artist drew this picture of a bison on a cave wall in Spain thousands of years ago.

HOW AND WHY

These books answer the questions most often asked about science, nature and history. They are presented in a clear, readable style, and contain many colourful and instructive illustrations. Readers will want to explore each of these fascinating subjects and collect these volumes as an authentic, ready-reference, basic library.

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